

NATIONAL WATER QUALITY NETWORK - SUPPLEMENT 2

Plankton Population Dynamics

from a study conducted JULY 1, 1959-JUNE 30, 1961

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Public Health Service
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RELATED PUBLICATIONS

National Water Quality Network

Annual Compilation of Data, October 1, 1957-September 30, 1958

Public Health Service Publication No. 663 (1958 Edition)

National Water Quality Network

Statistical Summary of Selected Data, October 1, 1957-September 30, 1958

Public Health Service Publication No. 663—Supplement 1

National Water Quality Network

Annual Compilation of Data, October 1, 1958-September 30, 1959

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National Water Quality Network

Annual Compilation of Data, October 1, 1959-September 30, 1960

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FOREWORD

The chemical, physical and biological characteristics of surface waters are inter-related phenomena. Making greater use of the stream biota to determine existing, and to forecast future, water quality in the stream offers promising possibilities. Plankton studies within the National Water Quality Network have included extensive work designed to permit application of the principle of diatom species diversity to the development of water quality indices. The studies required development of new laboratory analytical techniques, as well as preliminary application of the methodology to surface water samples from the many diverse Network sampling points.

Published herein are data from samples collected in the 2-year period July 1959 through June 1961 at 65 of the Network stations. While this work is continuing within the Network program, it is hoped that the material here presented will enable workers in this field to evaluate the techniques described by applying them more broadly.

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Plankton Population Dynamics



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Charts of Sampling Stations

Station	Page	Station	Page	Station	Page
ANIMAS RIVER		LAKE MICHIGAN		OHIO RIVER	
Cedar Hill, N. Mex.	26	Milwaukee, Wis.	46	Cairo, Ill.	69
APALACHICOLA RIVER		LAKE SUPERIOR		Evansville, Ind.	70
Chattahoochee, Fla.	27	Duluth, Minn.	47	Cincinnati, Ohio.	71
ARKANSAS RIVER		LAKE SUPERIOR, ST. MARY'S RIVER		Huntington, W. Va.	72
Pendleton Ferry, Ark.	28	Sault Ste. Marie, Mich.	48	East Liverpool, Ohio.	73
Ponca City, Okla.	29	HUDSON RIVER		POTOMAC RIVER	
Coolidge, Kans.	30	Poughkeepsie, N.Y.	49	Great Falls, Md.	74
CHATTAHOOCHEE RIVER		ILLINOIS RIVER		Williamsport, Md.	75
Columbus, Ga.	31	Peoria, Ill.	50	RED RIVER (NORTH)	
Atlanta, Ga.	32	KANAWHA RIVER		Grand Forks, N. Dak.	76
COLORADO RIVER		Winfield, W. Va.	51	RED RIVER (SOUTH)	
Yuma, Ariz.	33	KLAMATH RIVER		Alexandria, La.	77
Page, Ariz.	34	Keno, Oreg.	52	Index, Tex.	78
Loma, Colo.	35	LITTLE MIAMI RIVER		Denison, Tex.	79
COLUMBIA RIVER		Cincinnati, Ohio.	53	RIO GRANDE RIVER	
Clatskanie, Oreg.	36	MISSISSIPPI RIVER		Brownsville, Tex.	80
Bonneville, Oreg.	37	E. St. Louis, Ill.	54	Laredo, Tex.	81
Pasco, Wash.	38	Burlington, Iowa.	55	El Paso, Tex.	82
Wenatchee, Wash.	39	Dubuque, Iowa.	56	ST. LAWRENCE RIVER	
DELAWARE RIVER		St. Paul, Minn.	57	Massena, N.Y.	83
Philadelphia, Pa.	40	New Orleans, La.	58	SAVANNAH RIVER	
Marlins Creek Pa.	41	Delta, La.	59	Port Wentworth, Ga.	84
GREAT LAKES		W. Memphis, Ark.	60	N. Augusta, S.C.	85
LAKE ERIE, NIAGARA RIVER		Cape Girardeau, Mo.	61	SCHUYLKILL RIVER	
Buffalo, N.Y.	42	MISSOURI RIVER		Philadelphia, Pa.	86
LAKE HURON, DETROIT RIVER		St. Louis, Mo.	62	SNAKE RIVER	
Detroit, Mich.	43	Kansas City, Kans.	63	Wawawai, Wash.	87
LAKE HURON, ST. CLAIR RIVER		St. Joseph, Mo.	64	Weiser, Idaho.	88
Port Huron, Mich.	44	Omaha, Nebr.	65	TENNESSEE RIVER	
LAKE MICHIGAN		Yankton, S. Dak.	66	Chattanooga, Tenn.	89
Gary, Ind.	45	Bismarck, N. Dak.	67	YELLOWSTONE RIVER	
		Williston, N. Dak.	68	Sidney, Mont.	90

The National Water Quality Network

The Public Health Service program for providing fundamental information on the quality of the Nation's waters stems from Public Law 660, approved July 9, 1956, as amended by Public Law 87-88, July 20, 1961. Section 4(c) thereof states: ". . . the Secretary [of Health, Education, and Welfare] shall, in cooperation with other Federal, State, and local agencies having related responsibilities, collect and disseminate basic data on chemical, physical, and biological water quality insofar as such data or other information relate to water pollution and the prevention and control thereof."

To fulfill this responsibility, the National Water Quality Network collects, interprets, and disseminates:

- a. Information on changes in water quality at key points in river systems, as such quality may be affected by changes in water use and development.
- b. Continuous information on the nature and extent of pollutants affecting water quality.
- c. Data which will be useful in the development of comprehensive water resources programs.
- d. Data which will assist State, interstate, and other agencies in their water pollution control programs, and in the selection of sites for legitimate water uses.

Some 50 sampling stations were established when the program started, October 1, 1957. By January 1, 1962, the number had grown to 102.

Each sampling location satisfied one or more of the following criteria:

- a. Major waterways used for public water supply, propagation of fish and wildlife, recreational purposes, and agricultural, industrial, and other legitimate uses.
- b. Interstate, coastal, and international boundary waters.
- c. Waters on which activities of the Federal Government may have an impact.

Sampling station sites are fixed only after consultation with local, State, Federal and other agencies having related interests.

Active local participation is important in this operation. It assures maximum development of all information valuable both locally and nationally. Program costs are shared by the Federal Government and State and local agencies, those of the latter through contributions of laboratory and sampling manpower. Specifically, the State and local agencies perform most of the conventional chemical analyses and collect samples for the newer, more complex examinations. The Public Health Service, in turn, performs the more complex determinations and makes the results available to the participants. In addition, the consultation, training facilities, and other resources of the Public Health Service are available to the cooperating agencies.

Locations of sampling stations in operation as of January 1, 1962, are shown on page 3. Descriptions of the stations, participating agencies, and other pertinent information are presented on pages 5-8.

Only after careful screening of needs in water resource development was a pattern set for analyses of water samples. All Network samplings are examined for:

- a. Radioactivity.
 - (1) Gross alpha.
 - (2) Gross beta
 - (3) Strontium 90
- b. Plankton populations.
- c. Coliform organisms.
- d. Organic chemicals
- e. Biochemical, chemical, and physical measurements, including biochemical oxygen demand (B.O.D.), dissolved oxygen (D.O.), chemical oxygen demand (C.O.D.), chlorine demand, ammonia nitrogen, hydrogen ion concentration (pH), color turbidity, temperature, alkalinity (or acidity), hardness, chloride, sulfate, phosphates, and total dissolved solids.
- f. Trace elements.

Samples for groups a, c, and e are collected and analyzed weekly. Samples for organic chemicals are collected monthly, while the schedule for plankton organism examinations is semimonthly. Strontium 90 analyses are made on composites of weekly samples accumulated over a 3-month period. Trace elements are determined

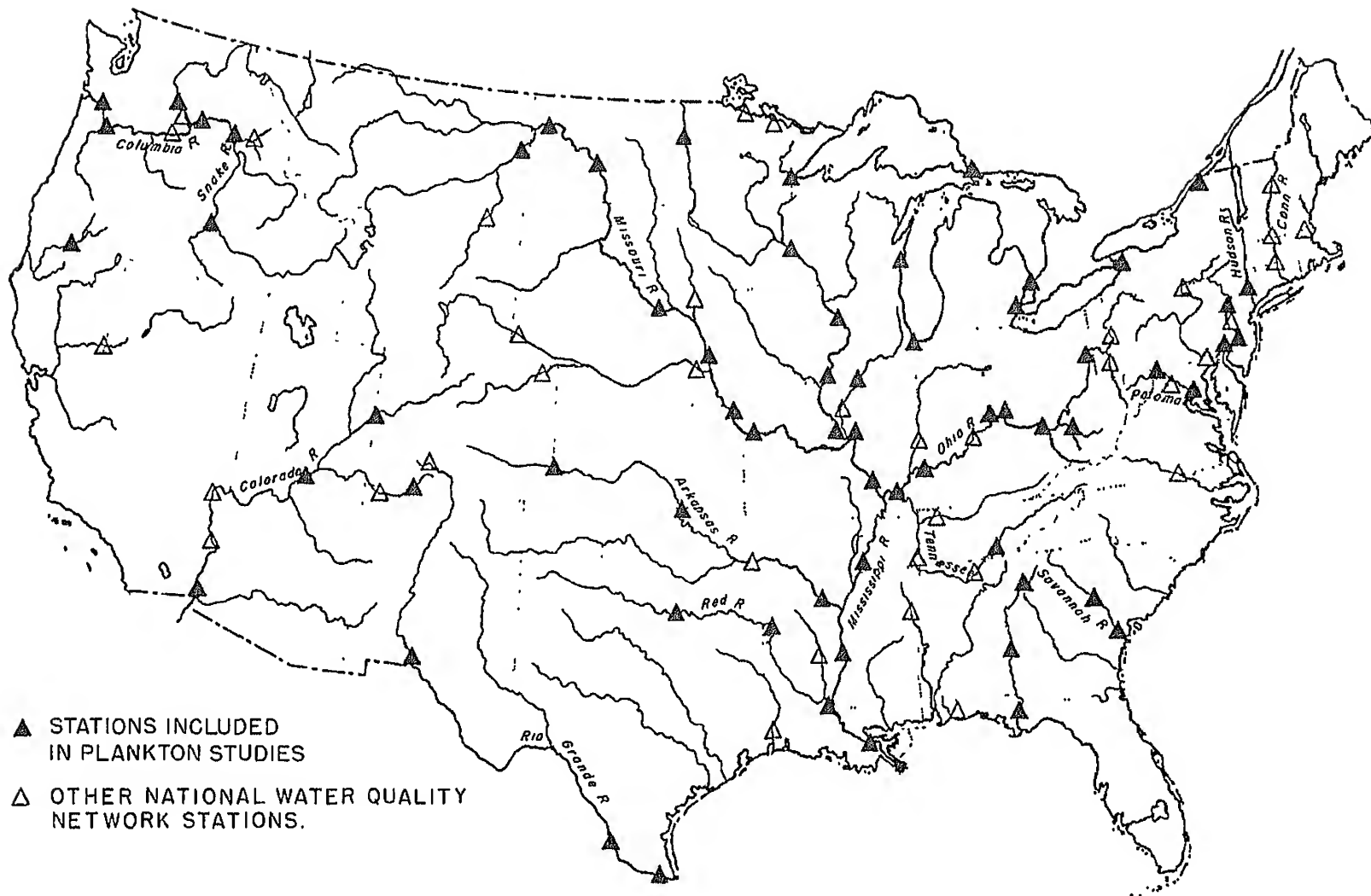
on 2-month composites of weekly samples. New parameters which are developed and found significant are included as the program continues.

Water Quality Parameters

In the assessment of water quality, all of the legitimate purposes for which raw waters can be used, and which may be affected by pollution, must be considered. These may range from the minimum requirements necessary for navigation to the ultimate in water quality demanded for special industrial processing. Quality needs differ considerably, therefore, according to water use.

For domestic use water must be free of disease organisms, clear, colorless, taste- and odor-free, and must have a relatively low dissolved mineral content. Agricultural water is judged primarily on its mineral content, especially with respect to the ratio between sodium and other cations, and the presence of boron. Water for fish propagation and recreational purposes must be relatively free from domestic and industrial pollution and must be able to sustain an active flora of the smaller aquatic organisms on which fish and wildlife feed. Industrial water quality demands run the gamut from the complete absence of minerals to a requirement of low temperature, the critical factor in water used for cooling. The effects of radioactive materials on these uses have not yet been fully appraised.

National Water Quality Network Sampling Stations



Introduction to the Plankton Studies

Although many water quality and water pollution studies have been made of rivers, there has been relatively little investigation of plankton in relation to water quality. This supplemental report presents information on the plankton populations found at 65 selected stations of the National Water Quality Network. Findings reported are based upon semimonthly samplings over a 2-year period ending June 30, 1961.

Plankton are composed of algae and other plant and animal organisms, and they do have an important relationship to the quality of the water in which they live. Always present in lakes and streams, these minute organisms are vital to water's self purification process. They take up and concentrate radionuclides from the water and when the cells die, they release radionuclides in the water.

Plankton also provide food for fish and other aquatic life. They sometimes cause taste and odor problems in water supplies. They may hinder water treatment by clogging filters. Often they become so abundant as to cause a nuisance in recreational areas and deplete oxygen in the water during decomposition. Because they exhibit population dynamics, plankton can serve as important indicators of water quality. For example, pollutants in the water may alter drastically the normal population patterns of plankton—an effect which may be observed through plankton population studies.

The data herein documented will be especially valuable because

identification and enumeration of the organisms were given uniform treatment, making comparisons relevant. Most other studies deal only with the larger net plankton and are not year-round studies.

In 1957 when the Network program was inaugurated, 16 sampling stations were in use on a monthly basis. At this time all diatoms including empty shells were included in the total counts. By 1959 the sampling schedule became semimonthly and the inert diatom shells were counted, separated and excluded from the total phytoplankton counts. The clump count procedure is used to tally the plankton organisms per ml. This includes all of the preservable algae larger than bacteria. In this method each single cell and natural clump or colony is recognized as a unit. From these data one may use a factor to determine other standard units.

All plankton which can be recognized in the preserved samples are being identified. These include fungi, sheathed bacteria, protozoa, crustaceans, rotifers, nematodes, and other invertebrates. Although these represent a small segment of the total population, their presence is noted for possible future use in studies of their relationship to water quality.

Much of the emphasis in the plankton program has been on diatoms. Both in total population and number of species they constitute the largest planktonic group in the rivers and Great Lakes. They are important indicators of water quality and its variations.

SAMPLING STATIONS AND COOPERATING AGENCIES

STATION	MILES ABOVE MOUTH	DESCRIPTION	SAMPLED BY	OTHER COOPERATING AGENCIES
ANIMAS RIVER above Cedar Hill, N. Mex.	33	Heizer Ranch at natural gas pipe- line crossing.	San Juan County Health Dept.	New Mexico Dept. of Public Health
APALACHICOLA RIVER at Chatahoochee, Fla.	105	Jim Woodruff Dam Powerhouse	U.S. Army Corps of Engineers Florida State Hospital, Chatta- hoochee, Florida.	Florida State Board of Health
ARKANSAS RIVER at Pendleton Ferry, Ark.	45	Ferry Landing, South Shore	Arkansas State Water Pollution Control Commission	Arkansas State Board of Health
at Ponca City, Okla.	646	Old U.S. Highway No. 60 Bridge (formerly at Osage Station, Okla. Gas and Electric Co.)	Ponca City Water Dept.	Oklahoma State Dept. of Health
at Coolidge, Kans.	1,099	U.S. Geological Survey Stream Gaging Station	U.S. Geological Survey	Kansas State Board of Health Colorado State Dept. of Health
CHATTAHOOCHEE RIVER at Columbus Ga.	160	Columbus Water Dept. Plant Intake	Columbus Water Dept.	Georgia State Dept. of Public Health
at Atlanta, Ga.	303	Atlanta Water Dept. Plant Intake	Atlanta Water Dept.	Georgia State Dept. of Public Health
COLORADO RIVER at Yuma, Ariz.	91	Arizona Water Co. Intake	Arizona Water Co.	Arizona State Dept. of Health
at Page, Ariz.	775	Page Water Plant Intake	U.S. Bureau of Reclamation	Arizona State Dept. of Health Utah State Dept. of Health
near Loma, Colo.	1,150	Pumping Station at E.R. Smith Farm	Mesa County (Colorado) Dept. of Public Health	Colorado State Dept. of Public Health
COLUMBIA RIVER near Clatskanie, Oreg.	53	Beaver Army Terminal U.S. Army Transp. Supply and Maintenance Command	U.S. Army U.S. Public Health Service	
at Bonneville Dam, Wash.- Oreg.	145	Bonneville Dam Powerhouse	U.S. Army Corps of Engineers	Oregon State Sanitary Authority Washington State Dept. of Health Washington State Pollution Control Commission
at Pasco, Wash.	327	Municipal Water Plant Intake	Pasco Water Dept.	Washington State Dept. of Health Washington State Pollution Control Commission
at Wenatchee, Wash.	465	Plant Intake, Aluminum Co. of America	Aluminum Co. of America Chelan-Douglas County Health Dept.	Washington State Dept. of Health Washington State Pollution Control Commission

SAMPLING STATIONS AND COOPERATING AGENCIES—Continued

STATION	MILES ABOVE MOUTH	DESCRIPTION	SAMPLED BY	OTHER COOPERATING AGENCIES
DELAWARE RIVER at Philadelphia, Pa.	110	Municipal Water Plant Intake (Torresdale Plant)	Philadelphia Water Dept.	Pennsylvania State Dept. of Health
at Martins Creek, Pa.	191	at Martins Creek Steam Electric Station	Pennsylvania Power and Light Co	Pennsylvania State Dept. of Health
GREAT LAKES				
Lake Erie, Niagara River at Buffalo, N.Y.	—	Municipal Water Plant Intake	Buffalo Water Dept. Erie County (N.Y.) Health Dept.	New York State Dept. of Health Michigan State Dept. of Health
Lake Huron, Detroit River at Detroit Mich	29	Municipal Water Plant Intake (Water Works Park)	Detroit Board of Water Commis- sioners	Michigan State Water Resources Commission
Lake Huron St. Clair River at Port Huron, Mich	38	Municipal Water Plant Intake	City of Port Huron, Michigan	Michigan State Dept. of Health International Joint Commission Michigan State Water Resources Board
Lake Michigan at Gary, Ind	—	Gary-Hobart Water Corp. Intake	Gary-Hobart Water Corp.	Indiana State Board of Health
Lake Michigan at Milwaukee, Wis.	—	Municipal Water Plant Intake	City of Milwaukee, Wisconsin	Wisconsin State Board of Health
Lake Superior at Duluth, Minn	—	Municipal Water Plant Intake	Duluth Water, Gas and Sewage Treatment Dept.	Minnesota State Dept. of Health
Lake Superior, St. Mary's River at Sault Ste. Marie, Mich.	48	Municipal Water Plant Intake	Sault Ste. Marie Water Dept.	Michigan State Dept. of Health
HUDSON RIVER below Poughkeepsie, N.Y.	70 (est)	International Business Machine Corp. Plant Intake	International Business Machine Corp.	New York State Dept. of Health
ILLINOIS RIVER at Peoria, Ill.	166	Peoria Water Works Co. Plant Intake	Peoria Water Works Co.	Illinois State Dept. of Public Health
KANAWHA RIVER at Winfield Dam, W. Va.	30	Winfield Dam Power Plant	West Virginia Water Resources Commission	Kanawha Valley Power Company West Virginia State Dept. of Health
KLAMATH RIVER at Keno, Oreg	220	one mile below Copco Hydro- generating Plant	City of Klamath Falls Klamath County Health Dept.	California-Oregon Power Company
LITTLE MIAMI RIVER at Cincinnati, Ohio	2	Robert A. Taft Sanitary Engineer- ing Center Raw Water Intake	Public Health Service	City of Cincinnati, Ohio
MISSISSIPPI RIVER				
at East St. Louis, Ill.	1,166	East St. Louis Water Co. Intake	East St. Louis Water Co.	Illinois State Dept. of Public Health
at Burlington, Iowa	1,369	Municipal Water Plant Intake	Burlington Water Dept.	Iowa State Dept. of Health
at Dubuque, Iowa	1,549	U.S. Army Corps of Engineers Lock and Dam #11	Dubuque Water Dept.	Iowa State Dept. of Health
at Lock and Dam #3 below St. Paul Minn.	1,757	U.S. Army Corps of Engineers Lock and Dam #3	U.S. Army Corps of Engineers Minneapolis-St. Paul Sanitary District	Minnesota State Dept. of Health

SAMPLING STATIONS AND COOPERATING AGENCIES—Continued

STATION	MILES ABOVE MOUTH	DESCRIPTION	SAMPLED BY	OTHER COOPERATING AGENCIES
at New Orleans, La.	105	Municipal Water Plant Intake	New Orleans Sewage and Water Board	Louisiana State Dept. of Health
at Delta, La. (formerly at Vicksburg, Miss.)	433	River Landing, Delta Casting Yard, U.S. Corps of Engineers	Mississippi State Board of Health	Louisiana State Dept. of Health
at West Memphis, Ark.	726	Barge Terminal, Oklahoma-Mississippi River Products Lines, Inc.	Memphis (Tennessee) Light, Gas and Water Division	Arkansas State Board of Health Tennessee State Dept. of Public Health
at Cape Girardeau, Mo.	1,020	Missouri Utilities Co. Water Intake	Missouri Utilities Co.	Missouri State Dept. of Public Health and Welfare
MISSOURI RIVER at St. Louis, Mo.	36	Water Plant Intake, St. Louis County Water Co. and Howard Bend Plant, City of St. Louis	St. Louis County Water Dept. St. Louis Water Dept.	Missouri State Dept. of Public Health and Welfare
at Kansas City, Kans.	385	Municipal Water Plant Intake	Kansas City (Kansas) Board of Public Utilities	Kansas State Board of Health
at St. Joseph, Mo.	471	St. Joseph Water Co. Intake	St. Joseph Water Co.	Missouri State Dept. of Public Health and Welfare
at Omaha, Nebr.	642	Metropolitan Utilities Dist. Water Plant Intake	Metropolitan Utilities District	Nebraska State Dept. of Health
at Yankton, S. Dak.	841	Municipal Water Plant Intake	Yankton Water Dept.	South Dakota State Board of Health
at Bismarck, N. Dak.	1,377	Municipal Water Plant Intake	Bismarck Water Dept.	North Dakota State Dept. of Health
at Williston, N. Dak.	1,644	Municipal Water Plant Intake	Williston Water Dept.	
OHIO RIVER				
at Cairo, Ill.	3	Cairo Water Co. Intake	Cairo Water Co.	Illinois State Dept. of Public Health
at Evansville, Ind.	190	Municipal Water Plant Intake	Evansville Water Dept.	Indiana State Board of Health
at Cincinnati, Ohio	518	Municipal Water Plant Intake	Cincinnati Water Dept.	Ohio State Dept. of Health
at Huntington, W. Va.	677	Huntington Water Co. Intake	Huntington Water Corp.	West Virginia State Dept. of Health
at East Liverpool, Ohio	941	Municipal Water Plant Intake	East Liverpool Water Dept.	Ohio State Dept. of Health
POTOMAC RIVER				
at Great Falls, Md.	126	Washington, D.C. Water Plant Intake	U.S. Army Corps of Engineers	Maryland State Dept. of Health
at Williamsport, Md.	212	Hagerstown Municipal Water Plant Intake	Hagerstown Water Dept.	Maryland State Dept. of Health
RED RIVER (North) at Grand Forks, N. Dak.	296	Municipal Water Plant Intake	Grand Forks City Water Dept.	North Dakota State Dept. of Health
RED RIVER (South) at Alexandria, La.	122	Pumping Station on Levee near City Wells	Alexandria Water Dept.	Louisiana State Dept. of Health
at Index, Ark.	485	U.S. Highway No. 71 Bridge	Texarkana Water and Sewer Systems Arkansas State Water Pollution	Arkansas State Board of Health

SAMPLING STATIONS AND COOPERATING AGENCIES—Continued

STATION	MILES ABOVE MOUTH	DESCRIPTION	SAMPLED BY	OTHER COOPERATING AGENCIES
RIO GRANDE at Brownsville, Tex.	40	Brownsville Filtration Plant Plant #1 Intake	Brownsville Water Dept.	Texas State Dept. of Health
at Laredo, Tex.	356	Municipal Water Plant Intake	Laredo Water Dept.	Texas State Dept. of Health
at El Paso, Tex.	1,234	Municipal Water Plant Intake	El Paso Public Service Board	Texas State Dept. of Health
ST. LAWRENCE RIVER at Massena, N.Y.	422	Aluminum Foundry Plant Intake	Chevrolet Motor Div., General Motors Corp., Aluminum Foundry	New York State Dept. of Health
SAVANNAH RIVER at Port Wentworth, Ga.	22	State Highway No. 17 Bridge	Union Bag-Camp Paper Co. U.S. Army Corps of Engineers Chatham County Health Dept.	Georgia State Dept. of Public Health
at North Augusta, S.C.	217	Municipal Water Plant Intake	North Augusta Water Dept.	South Carolina State Dept. of Health
SCHUYLKILL RIVER at Philadelphia, Pa.	10	Municipal Water Plant Intake	Philadelphia Water Dept.	Pennsylvania State Dept. of Health
SNAKE RIVER at Wawawai, Wash.	111 (est)	Pumping Station at I. E. Wilson Farm	Washington State College	Washington State Dept. of Health
at Weiser, Idaho	354	Municipal Water Plant Intake	Weiser Water Dept.	Idaho State Board of Health
TENNESSEE RIVER at Chattanooga, Tenn.	467 (est)	City Water Company Intake	City Water Company of Chat- tanooga	Tennessee State Dept. of Public Health
YELLOWSTONE RIVER at Sidney, Mont.	30	Intake-Lewis and Clark Station Montana-Dakota Utilities Co.	Montana-Dakota Utilities Co.	Montana State Board of Health

Equipment, Materials and Methods

Samples of raw water are collected semimonthly from each Network station and sent for processing to the Public Health Service's Water Quality Laboratory, Cincinnati, Ohio. Each sample is taken directly from the river or lake, or from a continuously flowing intake (as at a water treatment plant) receiving the river or lake water.

The sample, consisting of three liters of untreated water, is added to 100 ml. of preservative (thimerosal, 0.16 percent, plus Lugol's solution, 1 percent) in a polyethylene sample bottle. The Lugol's solution stains parts of the cells making identification easier. It also aids in settling the plankton since the iodine causes some of them to lose gas and, therefore, their buoyancy. This preservative has been found to be effective for approximately 1 month during the warm seasons and longer during cool weather. One gram of sodium borate is added for each gram of thimerosal to help keep the thimerosal in solution.

Three analyses, each requiring one liter, are performed per sample: (1) the genera of phytoplankters are identified and enumerated using the Sedgwick-Rafter slide technique; (2) the genera of microinvertebrates, mostly rotifers and crustaceans, are settled, identified to genus and counted in a special microslide; and (3) the diatoms are settled, washed and made into a permanent hyrax slide from which are made proportional counts of the species and some of the varieties. These determinations are also used to qualify to genus the diatoms recorded in the Sedgwick-Rafter (step one) procedure and to make the proportional counts in step three.

Phytoplankters counted in the Sedgwick-Rafter slide include forms, measuring four microns or more. Clump counts are made

of fungi and sheathed bacteria. The Sedgwick-Rafter counts for total algae that were alive when collected are made as clump counts in which each single-celled individual or natural clump or colony of cells is enumerated as one. Diatom shells without chromatophores are tallied separately from preserved diatoms with chromatophores.

Because tiny centric and pennate diatoms cannot be adequately identified to genus from the Sedgwick-Rafter slide, their determination is dependent on accurate identification during proportional counting from permanent hyrax slides. However, all other algae are determined to genus, including the colonial diatoms *Melosira*, *Asterionella*, *Fragilaria* and *Tabellaria*. These diatoms form natural aggregates or colonies and can be recognized in a Sedgwick-Rafter cell. All other diatoms, however, are counted only as centrics or pennates since identification, even to genus, is often obscure with the resolution and magnification (200X) available in the Sedgwick-Rafter method. The identification and relative abundance of various diatom species are determined from a permanent hyrax slide and these findings are used to identify the genera of the diatoms in each Sedgwick-Rafter count.

In concentrating by centrifugation of raw samples low in phytoplankton a moderate proportion of buoyant forms is lost, broken apart or so compacted with their spines or gelatinous secretions that they cannot be redistributed randomly for counting under the microscope. For these reasons most of the quantitation of phytoplankters has been obtained from unconcentrated or undiluted raw water samples. The count is in a Sedgwick-Rafter slide using 20-power objectives and 10-power oculars, and is accomplished by

counting two lengthwise strips (about 500 microns) the width of the Whipple square.

These two strips represent a volume of about 0.05 ml. To obtain the number of plankters per ml., a factor of 20 to 22 is used, varying with the correction for preservative dilution and differences in calibration of the microscopes. Precise techniques have been developed for obtaining representative and geometrically accurate one-ml. samples for counting in the Sedgwick-Rafter slide.

For the rare occasions where concentrations of phytoplankton were necessary, settling proved to be the best method, affording the least loss or distortion of organisms. Furthermore, this concentration technique has the advantage of allowing the sediment to be washed with distilled water to free it of colloidal material and some of the silt particles, which interfere with optics in some of the turbid samples.

Identification of diatom species and their proportional census is done from incinerated frustules of diatoms settled and washed from a liter of sample. The washed sediment containing the diatoms is dried on a warming table on a number one coverglass, and this sediment is ashed in place on the coverslip on a red-hot hotplate. This method does not appear to change the minute identification markings of the siliceous cell walls and enables the two valves (epitheca and hypotheca), as well as the groups of cells attached to one another, to remain in a natural grouping, so that Sedgwick-Rafter counts and proportional counts can be matched.

Chemical cleaning was abandoned because bubbling separates the valves, distorts natural cell grouping, and tends to inflate the actual count. Permanent slide mounts are made with hyrax medium. The technique of settling, washing in distilled water, and mounting does not appear to alter the uniformity of the diatom species composition. Proportional counts are made with 90-power oil immersion apochromatic objectives and 10-power oculars containing a Whipple micrometer grid. Random strip counts are made until the total number of units reaches 200 to 300. Higher counts are necessary when one or two species are overwhelmingly abundant.

Identification to species is facilitated by the described techniques

in settling, washing and hyrax preparation, and by the use of the best optical lenses available.

Proportional counting of diatoms from permanent slides is on a modified unit-area basis, in which each single cell or each portion of a natural aggregate occupying up to 300 square microns is tallied as one unit, cells or aggregates occupying from 300 to 1,000 square microns as two, those 1,000 to 2,500 square microns as three, those 2,500 to 5,000 square microns as four, and those over 5,000 square microns as five. The Whipple grid makes this scaling simple. This system gives a slight weighting to the larger specimens and colonies, which are seldom numerically abundant, but it is basically the same as the Sedgwick-Rafter count used for enumerating the other phytoplankters. About 95 percent of the cells or clumps naturally fall into size class one or two.

Proportional Counting

The numbers and kinds of diatoms obtained from the one-liter sample aliquot usually provide sufficient organisms for a kinds-to-numbers determination. This involves identifying and counting enough diatoms of the four most abundant species and the remainder. For this analysis, counting of great numbers was found unnecessary; the percentages of the total diatom count are determined for the four most numerous species after counting only about 250 or so individuals. Further counting does not significantly change the proportion of the total population thus found to be represented by the four predominant species.

This more rapid method of determining the species diversity by using diatoms was developed because of the large number of samples processed from the National Water Quality Network. A trained counter requires about 45 minutes to read an average slide.

Some generalizations about community dynamics are possible because a separate tally is maintained for each species. The diatom charts (pages 15 and 16), showing the relative occurrence of the four species most abundant at 65 stations, dramatically show the distribution and species character of the Network.

Biotic Characterization of Waterways

The organisms most abundant at any sampling station at any given time are the most reliable key to conditions of the environment. Species present in relatively lower numbers may not be reliable for this purpose because they sometimes represent organisms washed into the stream from ponds, creeks and other minor aquatic habitats. Furthermore, the flowing together of two unlike principal streams may produce a segment of mixing water containing organisms that do not represent true environmental conditions. Surviving healthy organisms become reliable indicators when they continue to multiply in the new water mixture and become predominant.

The four most abundant diatom species reflect in most situations the environmental conditions in the streams and Great Lakes. They were used during this investigation to indicate differences in water quality and other environmental conditions. Rare organisms are frequently encountered in streams that receive biota from other streams or lakes with unlike environments. Relatively dense, healthy plankton populations of several species, however, are very useful, because they usually represent favorable environmental conditions.

In analyzing the plankton from the same rivers and lakes for over three years, one is impressed with the "personality" of each river and many of its stations, based on the kinds of dominant biota each supports. The person engaged in plankton identification and enumeration soon learns to recognize many of the rivers and even individual stations by the characteristic plankton each produces. The table on page 13, wherein letters are used to show the presence

of individual species, reveals the similarities among stations on a given stream. For example, similarities are noted between the stations of the Great Lakes and between those of the Columbia River. Also, the Southeast, the Northeast, the Southwest, and the upper and lower Mississippi River each have their characteristic diatom floras.

A decided marine influence at three of the Network stations is evidenced by the brackish diatoms always present. These are Poughkeepsie, New York on the Hudson River; Port Wentworth, Georgia on the Savannah River; and Philadelphia, Pennsylvania on the Delaware River. In addition, the diatoms of Port Wentworth include species typical of the South Atlantic coastal waters.

Some other coastal stations have shown marine influence after periods of low rainfall, which allows brackish water to back up during periods of high tide. *Cyclotella striata* is the most common species from these stations, but brackish species of *Coscinodiscus denarus* are also numerous.

Diatoms found in large numbers in all major drainage basins and the Great Lakes are *Diatoma vulgare*, *Fragilaria crotonensis*, *Melosira ambigua*, *Melosira granulata*, and *Stephanodiscus hantzschii*.

Diatoms characteristic of the Great Lakes (absent or extremely rare at river stations) are *Cyclotella comia*, *Cyclotella kutzingiana*, *Melosira binderana*, *Melosira islandica* and *Rhizosolenia erienne*.

Diatoms characteristic of the Arkansas, Colorado and Rio Grande rivers (arid regions with waters of high calcium carbonate hardness and often with high dissolved salts) are *Amphiprora alata*, *Amphiprora paludosa*, *Amphora ovalis*, *Biddulphia laevis*, *Caloneis amphisbaena*,

Pleurosigma delicatula, *Surirella brightwellii* and *Surirella striatula*. In the Red River (south) *Diploneis smithii* dominate.

Certain diatoms dominate for short periods at widely separated stations, but are characteristic for these stations by their abundance and high fidelity. The Southeast is represented by *Cyclotella pseudostelligera* and *Melosira distans* variety *alpigena*. Buffalo, New York and Peoria, Illinois are identified by the high incidence of *Stephanodiscus niagarae*. While *Tabellaria fenestrata* is widely distributed, it overwhelmingly dominates at Gary, Indiana.

In the Ohio River, except East Liverpool, Ohio, two species of *Melosira* are abundant: *M. ambigua* and *M. granulata*. A large centric diatom *Stephanodiscus niagarae* variety *magnifica* is characteristic of the Klamath River. The Colorado, Snake and Yellowstone rivers often have fossil species of diatoms.

The stations with the highest counts (productivity) are Peoria, Illinois; Ponca City, Oklahoma; St. Paul, Minnesota; Keno, Oregon and Grand Forks, North Dakota.

While Gary, Indiana has the highest productivity of the Great Lakes stations, its counts are low when compared with those of high productive river stations. In general the lowest production stations are on the Great Lakes and in the Southeast.

Most of the 65 stations represented in this report have their highest counts during February–May. Only 13 of the 65 had their highest counts during October–January.

High temperatures and impounded water promote dense populations of blue-green algae in the late summer and early fall at several stations such as Cincinnati on the Ohio River.

Heavy turbidity drastically reduces the planktonic biota, particularly evident in the lower Missouri river.

Achnanthes minutissima, reported by ecologists to be an indicator of high dissolved oxygen, is common in the headwaters of the Columbia River.

Asterionella formosa and *Diatoma elongatum* become abundant during cold water seasons.

Distribution of Most Abundant Species of Diatoms

RIVERS	Stations							
	1	2	3	4	5	6	7	8
-----	kPN	kdP	PVm	mPA				
-----	ZAW	kdL						
ne-----	kLY							
-----	Chj	kXL	kXL					
-----	Qdf	bhD	Bxg					
de-----	MIZ	IcP	FEB					
ch)-----	IMQ	MIc	MIc					
-----	QdI	QkT	QTi	dTI	IVd			
-----	Okd	Odb	Oda	dcI	cdL	DLe	LKD	
si-----	QdT	QdI	QdT	Qdc	dQI	IQT	QdT	dIQ
-----	TQJ							
-----	dWL	ALG						
-----	SKH	SQY						
-----	dQe							
es-----	NeR	PdU	PmO	Umx	Pmd	mPA	mQR	

These are the three species occurring most frequently in the one year period ending June 1st at each of the plankton study stations in 15 Network waterways (including the Great Lakes as a single unit). This three-species identification affords a simple, quick comparison of the most important diatoms and demonstrates the distinct "personalities" of the sampling stations. Each three-letter symbol represents a station and the stations (except the Great Lakes) are listed in upstream sequence beginning at the river mouth.

Key to Species

A	Achnanthes minutissima
B	Amphiprora paludosa
C	Anomoeoneis exilis
D	Asterionella formosa
E	Biddulphia laevis
F	Caloneis amphibia
G	Cocconeis placentula
H	Coscinodiscus denarius
I	Cyclotella meneghiniana
J	Cyclotella striata
K	Cymatosira beligica
L	Diatoma vulgare
M	Diploneis smithii
N	Fragilaria capucina
O	Fragilaria construens
P	Fragilaria crotonensis
Q	Melosira ambigua
R	Melosira binderana
S	Melosira distans alpicena
T	Melosira granulata
U	Melosira islandica
V	Melosira varians
W	Navicula cryptocephala
X	Navicula viridula
Y	Navicula sp.
Z	Nitzschia lanceolata group
a	Nitzschia linearis
b	Nitzschia palea type
c	Stephanodiscus astriae minutula
d	Stephanodiscus hantzschii
e	Stephanodiscus niagarae
f	Surirella brightwellii
g	Surirella ovata
h	Surirella striatula
i	Synedra acus
j	Synedra tabulata
k	Synedra ulna
l	Synedra vaucheriae
m	Tabellaria fenestrata
x	Other entity

Diatom Species Occurring at the Study Stations*

October 1959-June 1961

Achnanthes lanceolata Bréb.
Achnanthes minutissima Kütz.
Amphiprora alata Kütz.
Amphiprora paludosa W. Smith
Amphora ovalis Kütz.
Anomoeoneis exilis (Kütz.) Cleve
Asterionella formosa Hassall
Bacillaria paradoxa Gmelin
Biddulphia laevis Ehr.
Caloneis amphisbaena (Bory) Cleve
Ceratoneis arcus Kütz.
Cocconeis pediculus Ehr.
Cocconeis placentula Ehr.
Coscinodiscus rostratus (Ehr.) Grun.
Cyclotella atomus Hust.
Cyclotella comta (Ehr.) Kütz.
Cyclotella glomerata Bachm.
Cyclotella kutzingiana Thwaites
Cyclotella meneghiniana Kütz.
Cyclotella pseudostelligera Hust.
Cyclotella stelligera Cl. & Grun.
Cyclotella striata (Kg.) Grun.
Cymatopleura solea (Bréb.) W. Smith
Cymatosira belgica Grunow
Cymbella affinis Kütz.
Cymbella humida (Bréb.) Heurck
Cymbella ventricosa Kütz.
Diatoma anceps (Ehr.) Grunow
Diatoma elongatum C. A. Agardh
Diatoma vulgare Bory
Diploneis smithii (Bréb.) Cleve
Epithemia turgida (Ehr.) Kütz.
Epithemia sorex Kütz.
Eunotia pectinatis (Kütz.) Raben.

Fragilaria brevistriata Grun.
Fragilaria capucina Desm.
Fragilaria construens (E.) Grun.
Fragilaria crotonensis Kitton
Fragilaria leptostauron (Ehr.) Hust.
Fragilaria pinnata Ehr.
Fragilaria virescens Ralfs.
Frustulia vulgaris Thwaites
Gomphonema herculeana (Ehr.) Cleve
Gomphonema olivaceum (Lyngb.) C. Ag.
Gomphonema parvulum Kütz.
Gyrosigma kutzingii (Grun.) Cleve
Hantzschia amphioxys (Ehr.) Grun.
Melosira ambigua (Grun.) O. Müller
Melosira binderana Kg.
Melosira distans (Ehr.) Kütz.
 var. *alpigena* Grun.
Melosira granulata (Ehr.) Ralfs.
Melosira islandica O. Müller
Melosira varians C. A. Agardh
Meridion circulare (Grev.) C. A. Ag.
Navicula canalis Patrick
Navicula contenta Grun.
Navicula cryptocephala Kütz.
Navicula cuspidata Kütz.
Navicula hungarica Grun.
Navicula mutica Kütz.
Navicula notha Wallace
Navicula tripunctata (Mull.) Bory
Navicula viridula Kütz.
Nitzschia acicularis (Kütz.) W. Smith
Nitzschia apiculata (Gregory) Grun.
Nitzschia denticula Grun.
Nitzschia dissipata (Kütz.) Grun.

Nitzschia filiformis (W. Smith) Hust.
Nitzschia fonticola Grun.
Nitzschia holsatica Hust.
Nitzschia hungarica Grun.
Nitzschia linearis W. Smith
Nitzschia parvula Levis
Nitzschia sigma (Kütz.) W. Smith
Nitzschia sigmoidea (Ehr.) W. Smith
Nitzschia tryblionella Hantzsch
Pinnularia borealis Ehr.
Pleurosigma delicatulum W. Smith
Rhoicosphenia curvata (Kütz.) Grun.
Rhizosolenia eriensis H. L. Smith
Rhopalodia gibba (Ehr.) O. Müller
Stephanodiscus astraea (Ehr.) Grun.
 var. *minutula* (Kütz.) Grun.
Stephanodiscus dubius (Fricke) Hust.
Stephanodiscus hantzschii Grun.
Stephanodiscus niagarae Ehr.
Stephanodiscus niagarae Ehr.
 var. *magnifica* Fricke
Stephanodiscus tenuis Hust.
Surirella angustata Kütz.
Surirella brightwellii W. Smith
Surirella ovata Kütz.
Surirella striatula Turpin
Synedra acus Kütz.
Synedra pulchella Kütz.
Synedra nana Meister
Synedra tabulata (C. Ag.) Kütz.
Synedra ulna (Nitzsch) Ehr.
Synedra vaucheriae Kütz.
Tabellaria fenestrata (Lyngb.) Kütz.
Tabellaria flocculosa (Roth) Kütz.

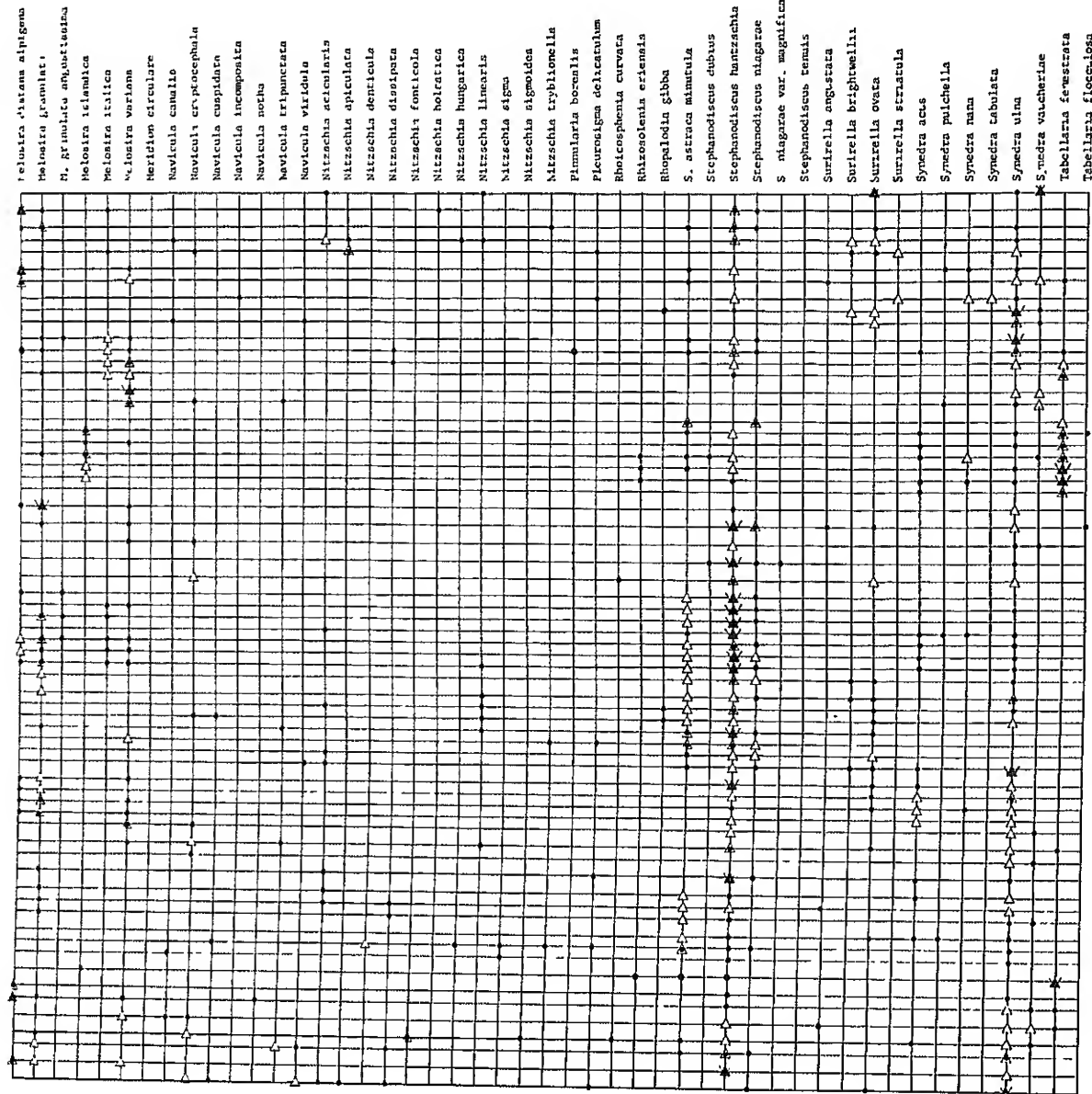
*Each species listed occurred one or more times in aggregate samplings as one of the four most abundant recorded at study stations in the 15 waterways involved.

Occurrence of Four Most Abundant Diatom Species (continued)

THE FOLLOWING TABLE SHOWS THE OCCURRENCE OF THE FOUR MOST ABUNDANT SPECIES OF DIATOMS

• = 1 to 25 PERCENT OF TOTAL TIME
 • = 26 to 50 PERCENT OF TOTAL TIME
 • = 51 to 75 PERCENT OF TOTAL TIME
 • = 76 to 100 PERCENT OF TOTAL TIME

STATION	DATE
STATION 1	1954
STATION 2	1954
STATION 3	1954
STATION 4	1954
STATION 5	1954
STATION 6	1954
STATION 7	1954
STATION 8	1954
STATION 9	1954
STATION 10	1954
STATION 11	1954
STATION 12	1954
STATION 13	1954
STATION 14	1954
STATION 15	1954
STATION 16	1954
STATION 17	1954
STATION 18	1954
STATION 19	1954
STATION 20	1954
STATION 21	1954
STATION 22	1954
STATION 23	1954
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STATION 26	1954
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STATION 82	1954
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STATION 84	1954
STATION 85	1954
STATION 86	1954
STATION 87	1954
STATION 88	1954
STATION 89	1954
STATION 90	1954
STATION 91	1954
STATION 92	1954
STATION 93	1954
STATION 94	1954
STATION 95	1954
STATION 96	1954
STATION 97	1954
STATION 98	1954
STATION 99	1954
STATION 100	1954



Green Flagellates at 48 Stations

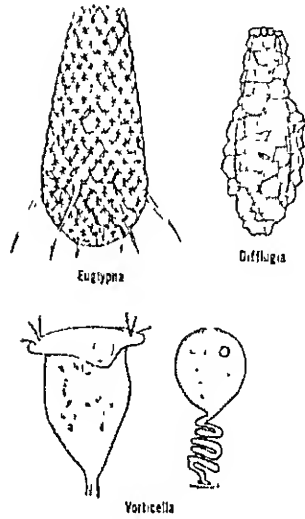
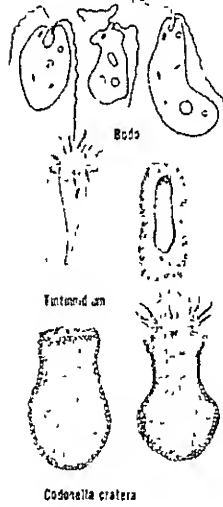
Because of the interest of some researchers in the use of green flagellate algae as potential indicators of organic enrichment, the compilation below is presented.

Semimonthly samples were used, beginning with the second sample in July 1960 through September 1961. Only those stations having uninterrupted sampling for this period are included. Average green flagellate counts for 48 stations for the 15-month period are shown below.

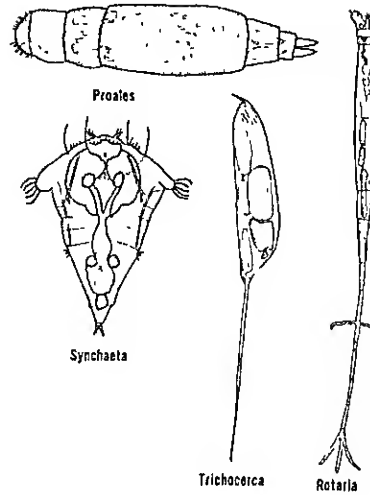
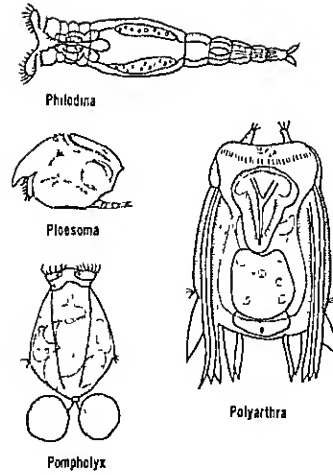
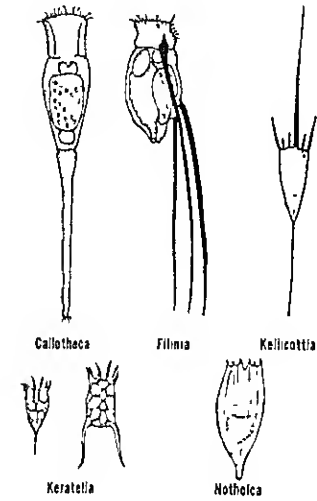
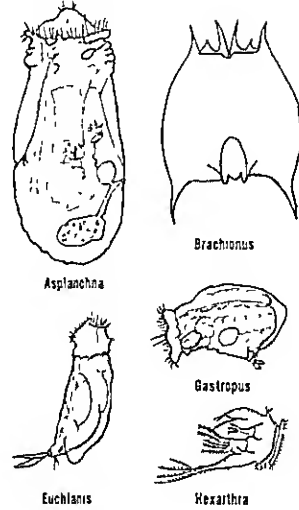
<i>River</i>	<i>Station</i>	<i>Counts/ ml</i>	<i>River</i>	<i>Station</i>	<i>Counts/ ml</i>
Missouri.....	Yankton, S. Dak.....	2,050	Mississippi.....	Delta, La.....	80
Mississippi.....	Minneapolis, Minn.....	481	Animas.....	Cedar Hill, N. Mex.....	72
Arkansas.....	Ponca City, Okla.....	466	Mississippi.....	W. Memphis, Ark.....	69
Ohio.....	E. Liverpool, Ohio.....	417	Colorado.....	Loma, Colo.....	67
Missouri.....	Omaha, Nebr.....	375	Arkansas.....	Pendleton Ferry, Ark.....	57
Chattahoochee.....	Columbus, Ohio.....	258	Hudson.....	Poughkeepsie, N.Y.....	51
Ohio.....	Evansville, Ind.....	252	Delaware.....	Martins Creek, Pa.....	51
Missouri.....	St. Joseph, Mo.....	226	Tennessee.....	Chattanooga, Tenn.....	51
Rio Grande.....	Brownsville, Tex.....	211	Red River (S).....	Denison, Tex.....	46
Ohio.....	Cincinnati, Ohio.....	196	Colorado.....	Yuma, Ariz.....	40
Missouri.....	Kansas City, Kans.....	176	Arkansas.....	Coolidge, Kans.....	37
Kanawha.....	Winfield, W. Va.....	167	Missouri.....	Bismarck, N. Dak.....	37
Yellowstone.....	Sidney, Mont.....	164	Colorado.....	Parker Dam, Ariz.-Calif.....	36
Missouri.....	St. Louis, Mo.....	162	Columbia.....	Bonneville, Oreg.....	35
Red River (S).....	Index, Tex.....	145	Columbia.....	Clatskanie, Oreg.....	33
Potomac.....	Great Falls, Md.....	139	Mississippi.....	New Orleans, La.....	31
Snake.....	Wawawai, Wash.....	138	Ohio.....	Cairo, Ill.....	29
Apalachicola.....	Chattahoochee, Fla.....	137	Lake Michigan.....	Gary, Ind.....	18
Colorado.....	Page, Ariz.....	134	Lake Erie.....	Buffalo, N.Y.....	15
Ohio.....	Huntington, W. Va.....	116	Lake Huron.....	Port Huron, Mich.....	12
Missouri.....	Williston, N. Dak.....	112	Lake Huron.....	Detroit, Mich.....	10
Mississippi.....	Dubuque, Iowa.....	89	Lake Superior.....	Duluth, Minn.....	3
Savannah.....	Port Wentworth, Ga.....	83	Lake Superior.....	Sault Ste. Marie, Mich.....	2
Mississippi.....	Cape Girardeau, Mo.....	82	Colorado.....	Boulder City, Nev.....	2

MICROINVERTEBRATES

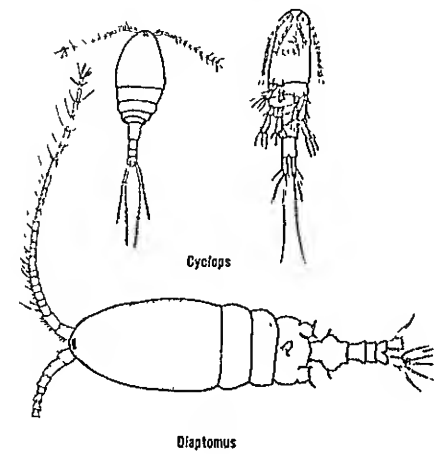
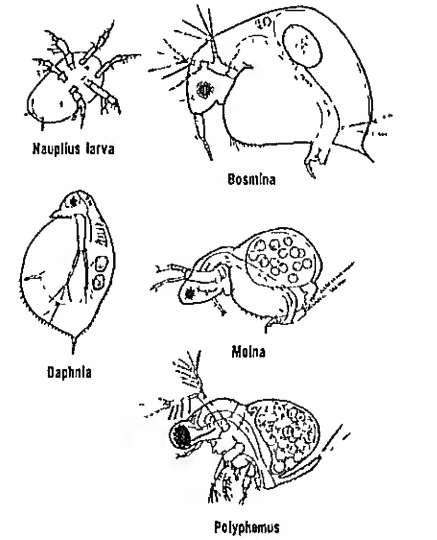
1-PROTOZOA



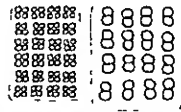
2-ROTIFERS



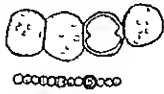
3-CRUSTACEA



1-BLUE-GREEN ALGAE



Agmenium (Merismopedium)



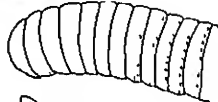
Anabaena



Anacystis (Microcystis)



Aphanizomenon

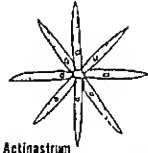


Oscillatoria



Phormidium

2-GREEN ALGAE



Actinastrum



Dictyosphaerium



Ankistrodesmus



Chlorococcum



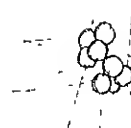
Cladophora



Lagerheimia (Chodatella)



Gelidium



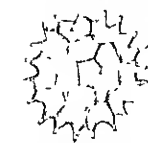
Micratinium



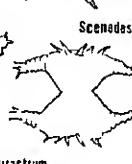
Oocystis



Scenedesmus



Pediatrum



Staurastrum



Lepocinctus



Phacus



Phacotus

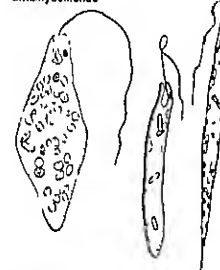


Trachelomonas

3-GREEN FLAGELLATES



Chlamydomonas

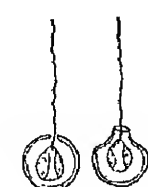


Eudorina

4-OTHER PIGMENTED FLAGELLATES



Chromulina



Chrysococcus



Rhodospirillum rubrum



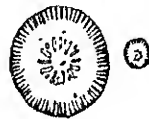
Rhodospirillum rubrum

DIATOMS

CENTRIC



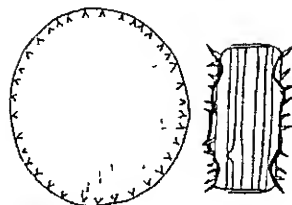
Cyclotella meneghiniana



Cyclotella stelligera



Cyclotella kuetzingiana



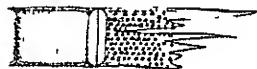
Stephanodiscus astraea



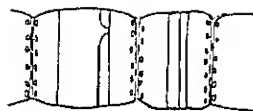
Stephanodiscus hantzschii



Melosira ambigua



Melosira granulata



Melosira binderana



Melosira varians

PENNATE



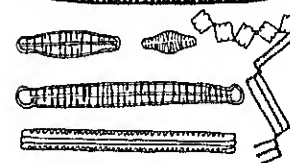
Achnanthes minutissima



Caloneis amphibaena



Cymbella tumida



Diatoma vulgare



Diploneis smithii



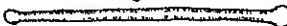
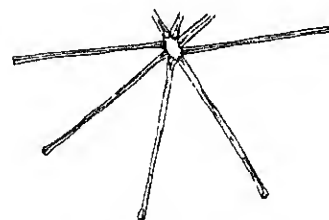
Synedra ulna



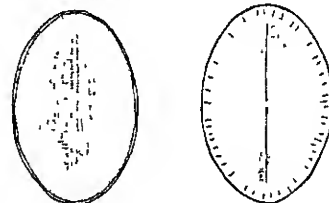
Suriella ovata



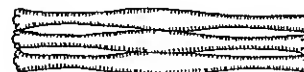
Gomphonema olivaceum



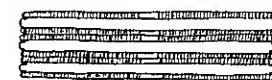
Asterionella formosa



Cocconeis pleocantula



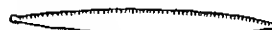
Fragilaria crotonensis



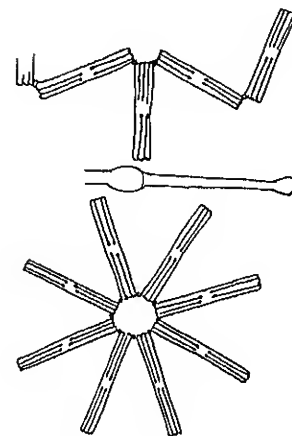
Fragilaria capucina



Navicula gracilis

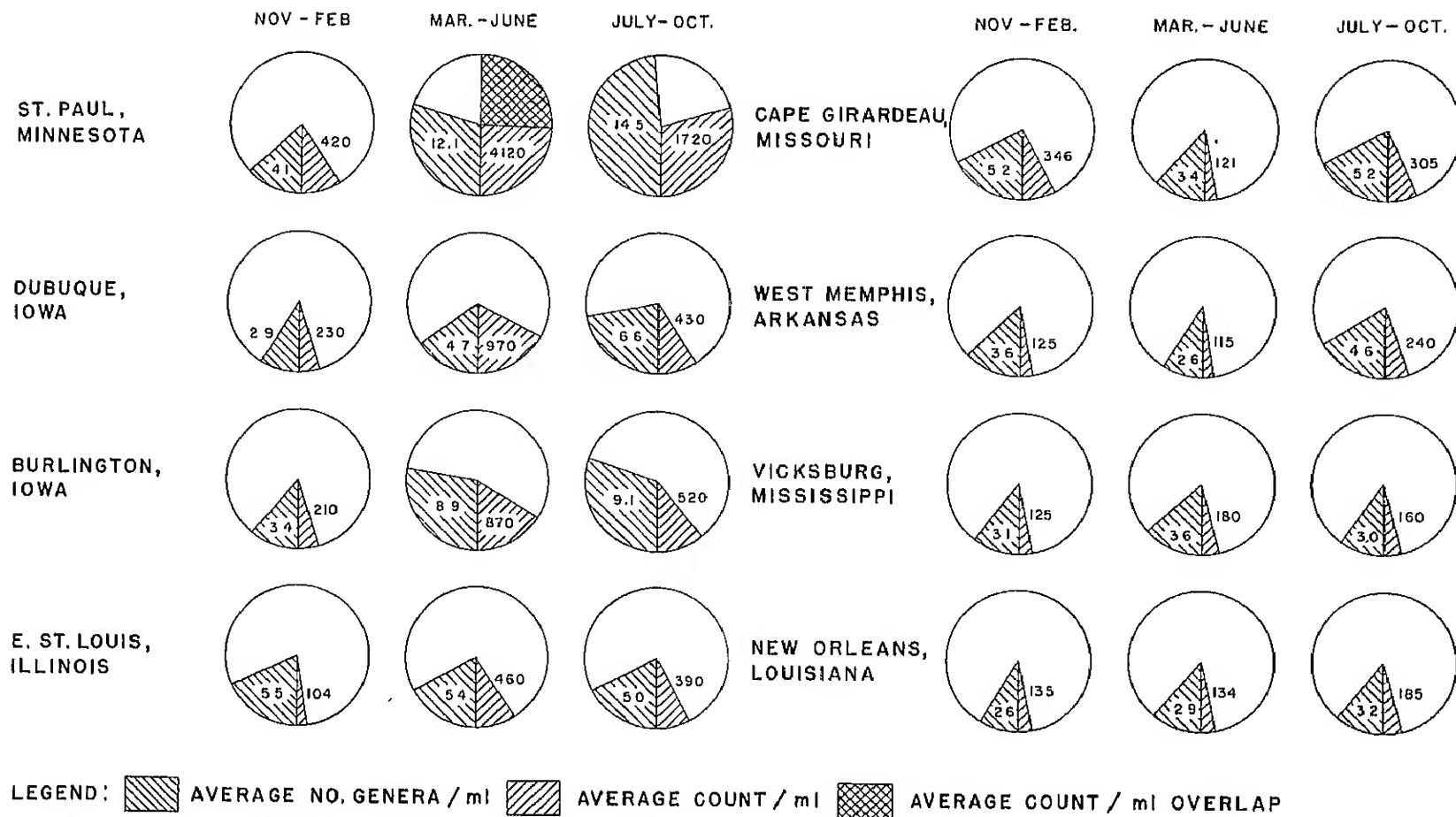


Nitzschia palea



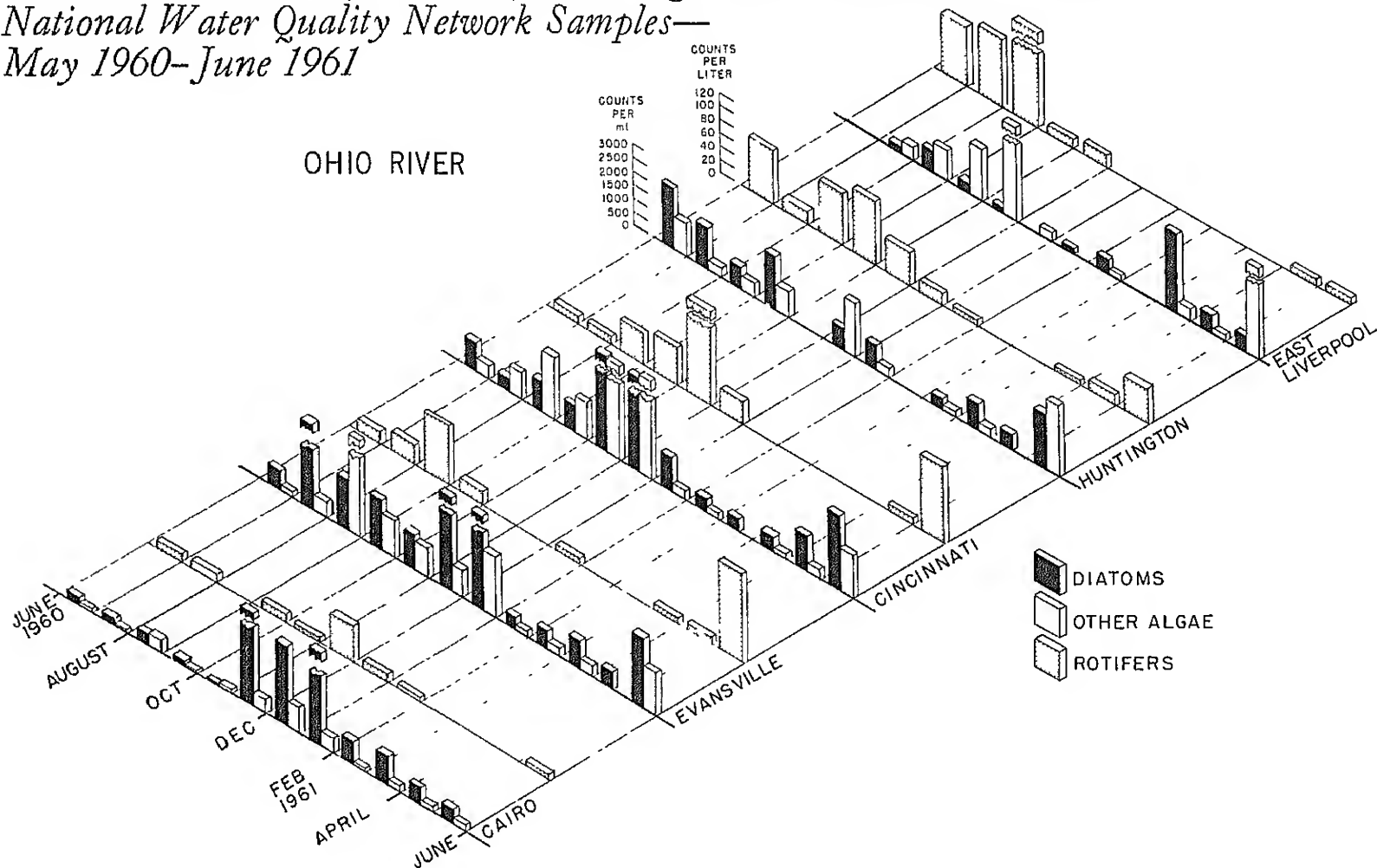
Tabellaria fenestrata

Planktonic Green Algae, Mississippi River—1959



Similarities or differences between sampling stations can be observed through separate reporting of the three major groups, diatoms, green flagellates, and rotifers. Charted above are planktonic green algae (nonflagellates) 4-month averages for the year 1959 at eight Mississippi River stations. The count decreases successively station by station downstream from St. Paul, Minn. to New Orleans, La. The average count per ml. for the whole year was 2,087 at St. Paul and 151 at New Orleans.

*Relative Abundance of Diatoms, Other Algae and Rotifers, Ohio River
National Water Quality Network Samples—
May 1960–June 1961*



Production by planktonic algae and consumption by planktonic rotifers has an important bearing on water quality. Wastes discharged into rivers may produce problems from overproduction by diatoms and other algae and underconsumption by microinvertebrates as the natural self-purification process takes place. To maintain water of high quality a balance of production and consumption is a desirable objective of stream management. A graphical presentation of this relationship for 5 sampling stations on the Ohio River is shown. Along the Ohio River the highest standing crops were observed during the late summer and early fall when flow rates are the lowest. Cincinnati, the midpoint station between the headwaters and river mouth, had the highest productivity of the 5 sampling stations.

Average Number of Rotifers Per Liter*

July 1960 through June 1961

<i>River</i>	<i>Station</i>	<i>Count</i>	<i>River</i>	<i>Station</i>	<i>Count</i>
Animas	Cedar Hill, N. Mex.	14.7	Mississippi (Lower)	New Orleans, La.	0.5
Apalachicola	Chattahoochee, Fla.	34.2		Delta, La.	0.8
Arkansas	Pendleton Ferry, Ark.	11.9		W. Memphis, Ark.	3.7
	Ponca, City, Okla.	39.0		Cape Girardeau, Mo.	2.8
	Coolidge, Kans.	4.5	Missouri	St. Louis, Mo.	0
Chattahoochee	Columbus, Ga.	125.2		Kansas City, Kans.	0
	Atlanta, Ga.	3.4		St. Joseph, Mo.	0.1
Colorado	Yuma, Ariz.	2.0		Omaha, Neb.	0.5
	Page, Ariz.	2.0		Yankton, S. Dak.	27.3
	Loma, Colo.	0.6		Bismarck, N. Dak.	4.8
Columbia	Clatskanie, Oreg.	46.8	Ohio	Williston, N. Dak.	0.9
	Bonneville Dam, Wash.-Oreg.	18.9		Cairo, Ill.	3.0
	Pasco, Wash.	3.9		Evansville, Ind.	71.0
	Wenatchee, Wash.	3.7		Cincinnati, Ohio	58.0
Delaware	Philadelphia, Pa.	9.0		Huntington, W. Va.	28.0
	Martins Creek, Pa.	6.3		E. Liverpool, Ohio	13.0
Great Lakes	Buffalo, N.Y.	66.1	Potomac	Great Falls, Md.	2.9
	Detroit, Mich.	16.2		Williamsport, Md.	1.4
	Port Huron, Mich.	22.2	Red (No.)	Grand Forks, N. Dak.	175.9
	Gary, Ind.	16.2	Red (So.)	Alexandria, La.	48.8
	Milwaukee, Wis.	8.3		Index, Tex.	8.0
	Duluth, Minn.	1.3		Denison, Tex.	6.0
	Sault Ste. Marie, Mich.	7.7	Rio Grande	Brownsville, Tex.	137.2
Hudson	Poughkeepsie, N.Y.	8.0		Laredo, Tex.	0.1
Illinois	Peoria, Ill.	242.2		El Paso, Tex.	2.1
Kanawha	Winfield, W. Va.	6.1	St. Lawrence	Massena, N.Y.	16.0
Klamath	Keno, Oreg.	161.3	Savannah	Port Wentworth, Ga.	1.0
Little Miami	Cincinnati, Ohio	85.2		N. Augusta, S.C.	2.0
Mississippi (Upper)	E. St. Louis, Ill.	45.0	Schuylkill	Philadelphia, Pa.	13.0
	Burlington, Iowa	18.0	Snake	Wawawai, Wash.	4.7
	Dubuque, Iowa	42.0		Weiser, Idaho	18.8
	St. Paul, Minn.	242.0	Tennessee	Chattanooga, Tenn.	22.5
			Yellowstone	Sidney, Mont.	0.8

*Semimonthly samples from 65 Stations of the National Water Quality Network.

Explanation Of Sampling Station Charts

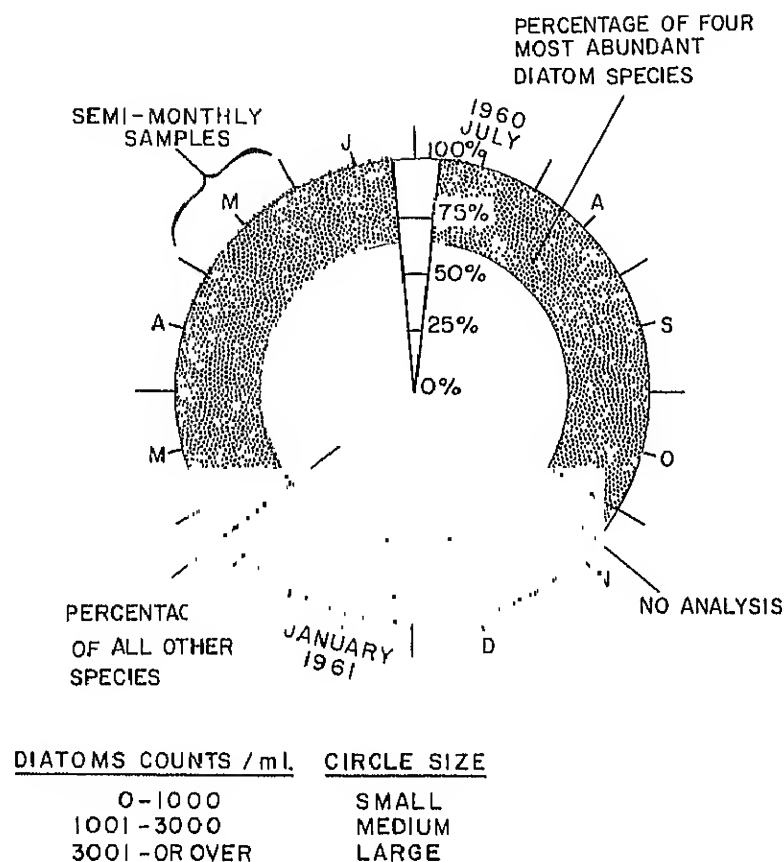
A. BAR GRAPH—Percent Occurrence and Relative Abundance of Diatoms.

The quality of surface waters at a given time may be indicated by the kinds and numbers of organisms they support. One effect of enrichment is a decrease in the diversity of the diatom species. The identification and relative abundance of the predominant diatom species is basic to the determination of their species diversity.

The bar graph, "Diatoms—Present Occurrence," lists those species of diatoms which appeared first, second, third or fourth in abundance in semimonthly samples taken during the period designated at 65 stations of the National Water Quality Network for the year beginning July 1, 1960. For those species in first or second place at any time, the graph presents the percent of the time they occurred as either first, second, third or fourth in abundance. For instance, in the Columbia River at Clatskanie, Oregon, *Synedra ulna* was the number one species 19 percent of the time, was in first or second place 32 percent of the time, was among the first three predominant species 51 percent of the time, and was among the first four 76 percent of the time. Species which never occurred in first or second place, but which did occur in third or fourth are listed, but their percent occurrence is not shown.

The percent occurrence in no way reflects the actual population density. A species second in abundance, for example, may be present in only small numbers; another may have occurred in large numbers in some samples, but because it was not among the first four, would not be listed.

Both the bar and circle graphs (see B, p. 25) deal with the same



sampling period. The bar graph includes species names and comprises one year's collection of data.

B. CIRCLE GRAPH—Diatoms, Species Diversity (See diagram at left).

While the bar graph is designed to show the percent occurrence and names of the four most abundant species for a year, the circle graph indicates the species diversity of diatoms at each of the 24 (semimonthly) sampling times for the year July 1960 through June 1961. Semimonthly samples are represented by radial lines extending from the perimeter of the circle. The short radial lines with month designations represent the second semimonthly samples normally taken during the third week of the month. The longer lines represent the first of the semimonthly samples. The months are recorded consecutively clockwise.

A total diatom population range is expressed in the size of the circle. Three circle sizes are used. A small circle (4 cm. in diameter) represents a diatom count of between zero and 1,000 per ml., a medium circle (6 cm. in diameter), between 1,001 and 3,000 per ml., and a large circle (8 cm.) above 3,001.

A total diatom population of any sample is represented as a percent by the radius designated for that sample. The percent of diatoms, other than the four most abundant species in a population, is determined by the distance from the center of the circle to a point on the radius. A quartile scale is given on a vertical radius of each circle. The central blank portion of the circle is formed by radially plotting percent of diatoms other than the four most abundant species. Sections shaded by the smaller dots represent samples not analyzed. Species diversity is indicated by the extension of the white area from the center of circle. Thus a line drawn to connect these points on the 24 radii inscribes a figure or pattern which may be characteristic for each station. As the central clear area extends outward greater species diversity is indicated. Correspondingly, less diversity is indicated as the outer dark area increases.

The perimeter is divided into evenly spaced sampling times and each circle graph shows the fluctuations in species diversity between

the 24 sampling times during the year. For example, species diversity is relatively great at Wawawai, Washington on the Snake River and relatively low at Grand Forks, North Dakota on the Red River. Many of the 65 circle graphs suggest seasonal patterns, with the least species diversity in late summer and fall. At Clatskanie, Oregon on the Columbia River, species diversity is greater during the winter months than the summer months.

C. LOGARITHMIC LINE GRAPH—Total Live Phytoplankton Counts.

Total live phytoplankton counts are plotted beginning with July 1959 for those stations that were in operation at that time. Counts are presented in a logarithmic scale on the vertical axis. The counts exclude the inert diatom shells. A summary of average seasonal total live phytoplankton counts is also presented. Seasonal periods averaged extend from June–September, October–January, and February–May.

D. TABLE OF ZOOPLANKTON

Four genera of rotifers were found to be very common in the major waterways of the United States by this study. The occurrence of these genera during the period July 1960 to July 1961 is presented with average counts per liter per sample. Column one presents the number of occurrences of all rotifers present in all samples. The second column gives the average count per liter based on all samples, whether or not rotifers were present.

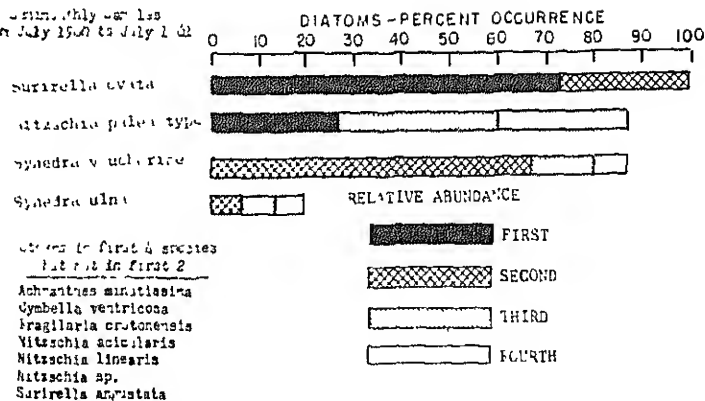
Similar treatment is given copepods, cladocerans, nauplii, nematodes and other invertebrate metazoans.

E. TABLE OF MOST ABUNDANT GENERA OF ALGAE

The most abundant genera of algae are recorded in tabular form, the criterion for inclusion being occurrence in numbers 150 per ml. or more. The percent occurrence in these numbers is presented. The table is broken down into major groups (blue-greens, greens, green flagellates, other pigmented flagellates, diatoms—centric and pennate). This permits comparisons among these major groups of algae.

ANIMAS RIVER CEDAR HILL, NEW MEXICO

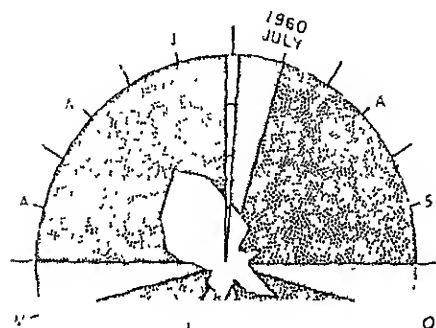
Sum. Only - see list
from July 1960 to July 1961



ZOOPLANKTON

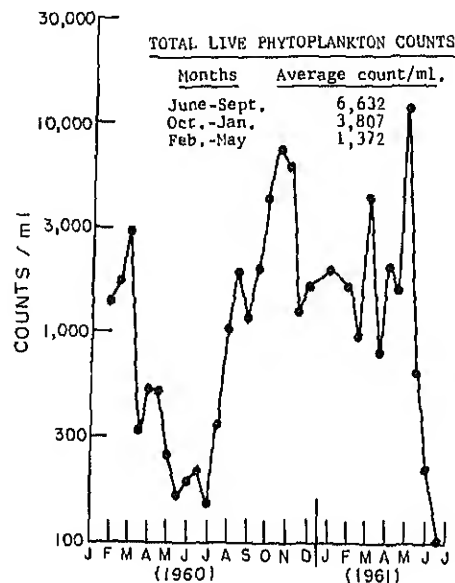
Samples analyzed 19
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers.	12	14.7
Keratella	2	0.3
Polyarthra	2	0.1
Brachionus	1	0.1
Synchaeta	0	0
Other genera	7	14.2
Cladocerans.		
nauplii	2	0.1
copepods	0	0
cladocerans	0	0
Nematodes		0
Other invertebrate metazoans		0



DIATOMS - SPECIES DIVERSITY

FIRST 4 MOST ABUNDANT
ALL OTHER SPECIES
NO ANALYSIS MADE



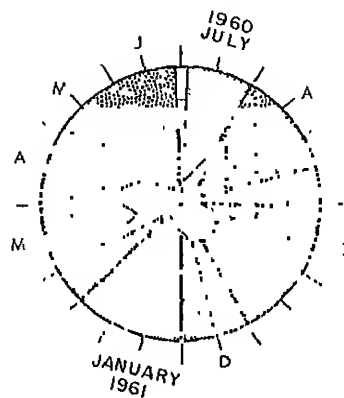
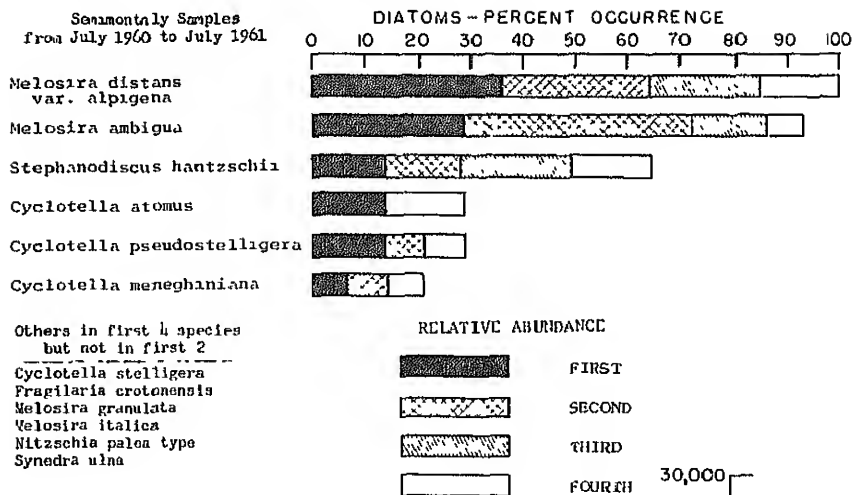
MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From Feb. 1960 to May 1961

Diatoms	
Pennate	
Achnanthes	14
Fragilaria	14
Gomphonema	7
Navicula	17
Nitzschia	35
Surirella	60
Synedra	71

APALACHICOLA RIVER CHATTAHOOCHEE, FLORIDA

Seasonally Samples
from July 1960 to July 1961



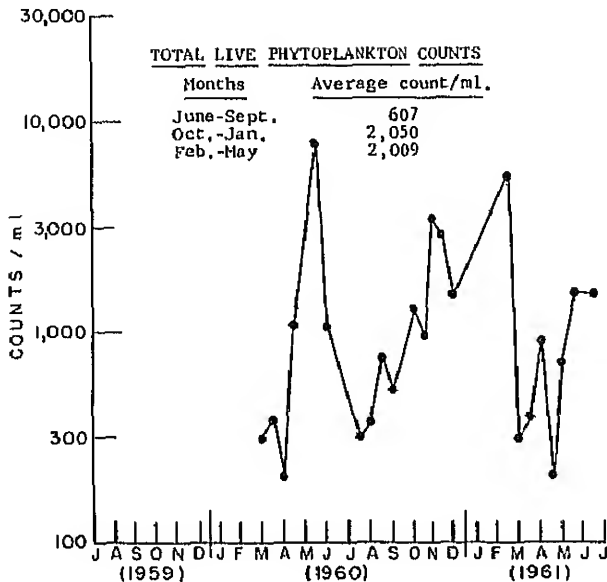
DIATOMS - SPECIES DIVERSITY

- FIRST 4 MOST ABUNDANT
- ALL OTHER SPECIES
- NO ANALYSIS MADE

ZOOPLANKTON

Samples analyzed 18
Aug. 1960 to July 1961

Samples with Animals	Average count per liter per sample
Rotifers:	17
Keratella	16
Polyarthra	13
Brachionus	4
Synchaeta	8
Other genera	14
Crustaceans:	
nauplii	3
copepods	1
cladocerans	3
Nematodes	
Other invertebrate metazoans	0



MOST ABUNDANT GENERA OF ALGAE

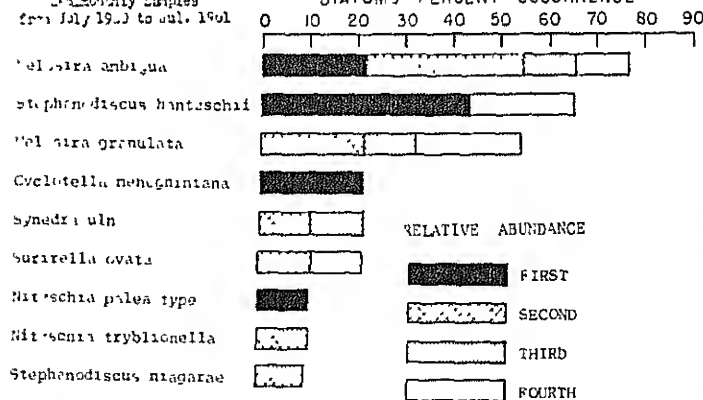
Percent frequency of counts
150 per ml. or more
From March 1960 to May 1961

Green algae	
Scenedesmus	9
Green flagellates	
Phacotus	4
Trachelomonas	9
Other pigmented flagellates	
Chromulina	0
Diatoms	
Centric	
Cyclotella	28
Melosira	42
Stephanodiscus	28
Pennate	
Asterionella	14
Navicula	4
Nitzschia	4
Synedra	9

ARKANSAS RIVER PENDLETON FERRY, ARKANSAS

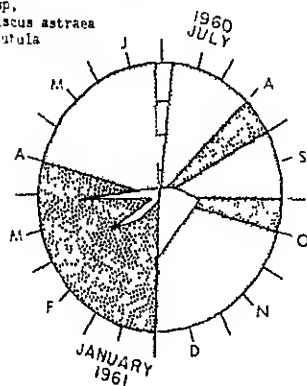
Randomly Samples
from July 1959 to July 1961

DIATOMS - PERCENT OCCURRENCE



Others in first 4 species
but put in first 2

Amphiprora palutosa
Melosira distans var. *albigena*
Navicula sp.
Stephanodiscus astraea
var. *minutula*



DIATOMS - SPECIES DIVERSITY

FIRST 4 MOST ABUNDANT
ALL OTHER SPECIES
NO ANALYSIS MADE

ZOOPLANKTON

Samples analyzed 13
July 1960 to July 1961

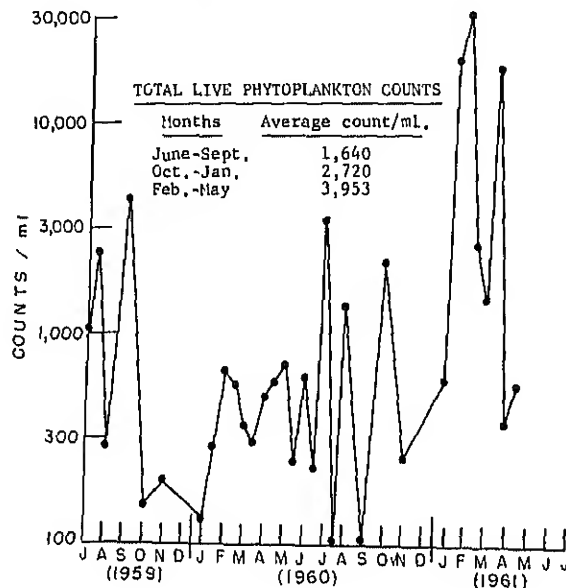
Samples with Animals Average count per liter per sample

Rotifers.	6	11,9
Keratella	2	0
Polyarthra	4	0,5
Brachionus	2	10,9
Synchaeta	0	0
Other genera	2	0,5
Crustaceans.		
nauplii	1	0
copepods	2	0,5
cladocerans	1	0
Nematodes		5
Other invertebrate metazoans	0	0

MOST ABUNDANT GENERA OF ALGAE

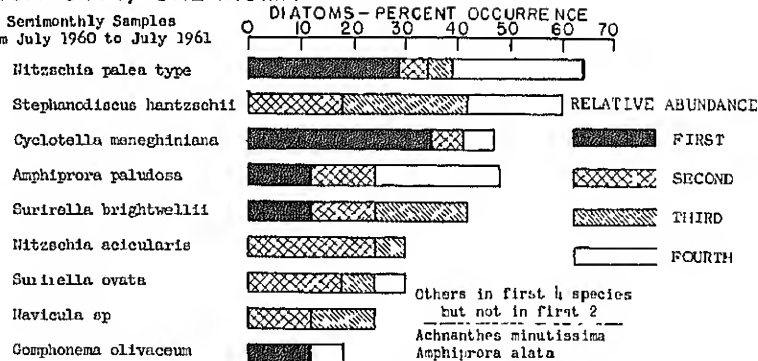
Percent frequency of counts
150 per ml or more
From May 1959 to May 1961

Blue-green algae	
Anacystis	3
Green algae	
Oocystis	3
Scenedesmus	3
Solenastrum	3
Stichococcus	3
Green flagellates	
Chlamydomonas	16
Euglena	3
Trachelomonas	11
Diatoms	
Centric	
Cyclotella	32
Melosira	16
Stephanodiscus	24
Pennate	
Amphiprora	3
Asterionella	3
Navicula	5
Nitzschia	11
Synedra	24



ARKANSAS RIVER PONCA CITY, OKLAHOMA

Serimonthly Samples
from July 1960 to July 1961



ZOOPLANKTON

Samples analyzed 22
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers:	7	39.0
Keratella	4	0.6
Polyarthra	1	0.3
Brachionus	5	36.0
Synchaeta	2	0
Other genera	2	1.4
Crustaceans:		
nauplii	4	0.2
copepods	3	0.1
cladocerans	0	0
Nematodes		2.0
Other invertebrate metazoans		none

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Blue-green algae

Aphanizomenon	3
Anacystis	5
Aphanizomenon	3
Gomphonema	5
Oscillatoria	3
Phormidium	3

Green algae

Actinastrium	16
Ankistrodesmus	11
Chlorella-type	3
Dictyocarpus	3
Golenkinia	3
Lagerheimia	3
Microcystis	3
Oocystis	3
Pediastrum	5
Scenedesmus	24

Green flagellates

Chlamydomonas	49
Euglena	5
Trachelomonas	5

Other pigmented flagellates

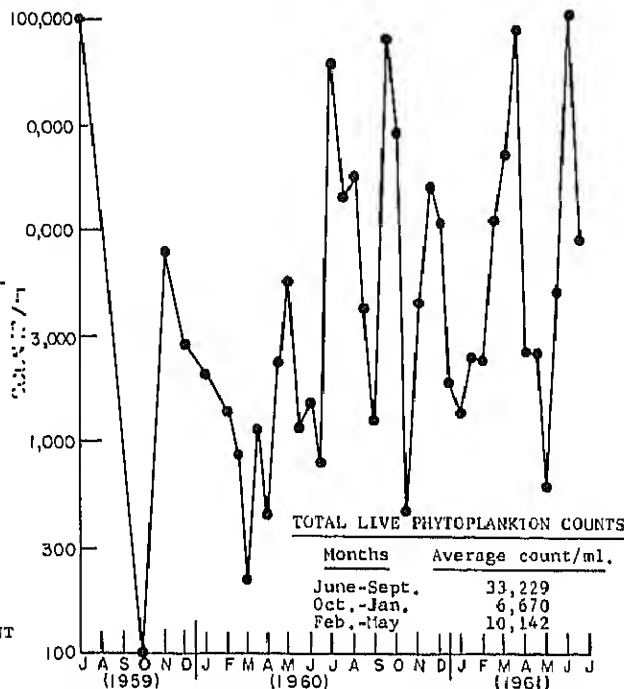
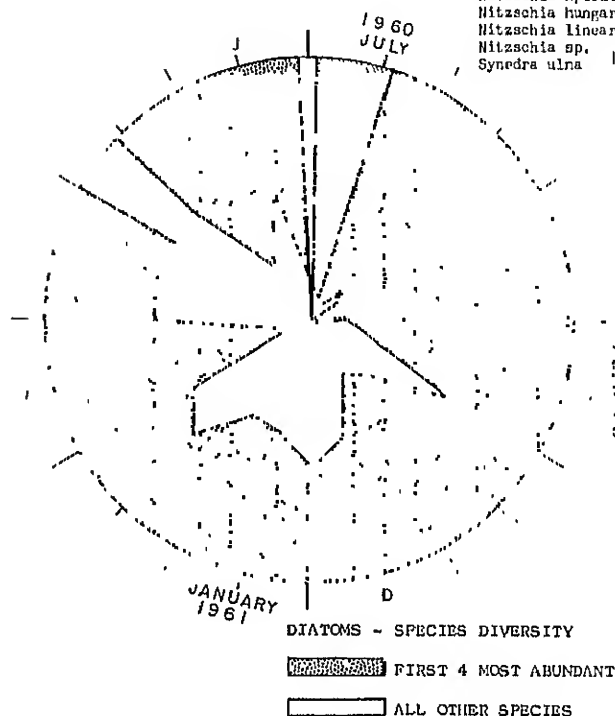
Gymnodinium	3
Peridinium	3

Diatoms

Centric	
Coscinodiscus	3
Cyclotella	73
Malosia	22
Stephanodiscus	39

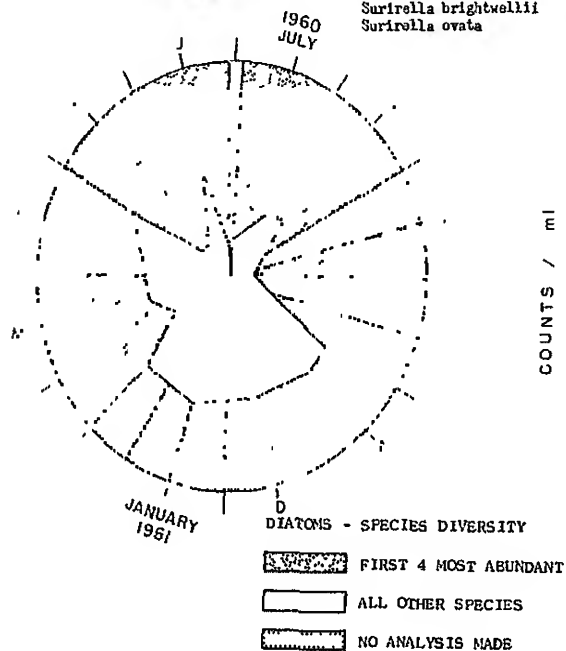
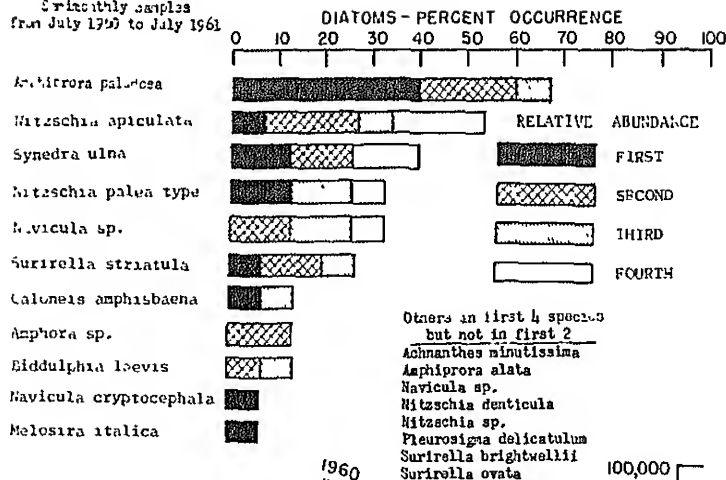
Pennate

Amphiprora	19
Gomphonema	8
Meridion	3
Opephora	3
Navicula	54
Nitzschia	54
Surirella	32
Synedra	25



ARKANSAS RIVER COOLIDGE, KANSAS

Stratified samples
from July 1959 to July 1961



ZOOPLANKTON

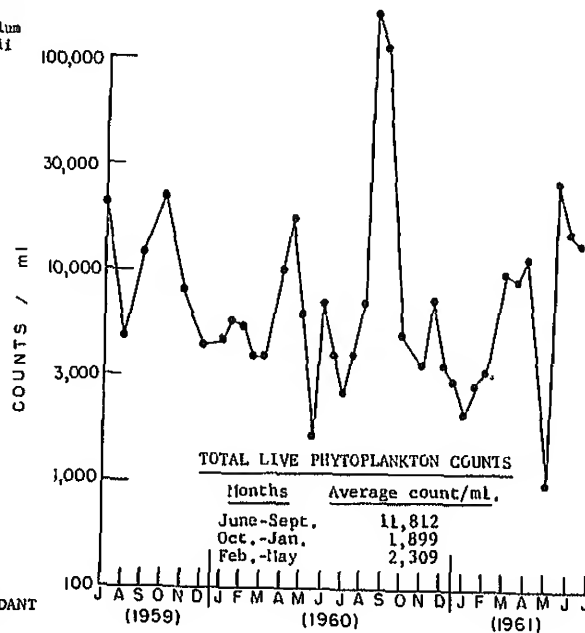
Samples analyzed 20
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers.	5	4,5
Keratella	0	0
Polyarthra	0	0
Brachionus	1	0
Synchaeta	0	0
Other genera	3	4,0
Crustaceans, nauplii	1	0,5
copepods	1	0
cladocerans	1	0
Nematodes		2
Other invertebrate metazoans		0

MOST ABUNDANT GENERA OF ALGAE

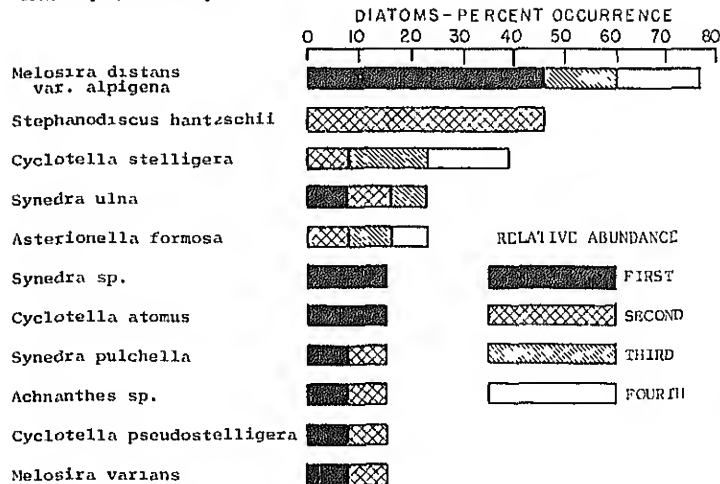
Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Blue-green algae	
Agmenellum	3
Aphanizomenon	3
Green algae	
Scenedesmus	6
Green flagellates	
Chlamydomonas	3
Other pigmented flagellates	
Peridinium	3
Diatoms	
Centric	
Cyclotella	18
Melosira	3
Pennate	
Achnanthes	3
Amphiprora	38
Amphora	9
Caloneis	3
Cocconeis	3
Gomphonema	9
Gyrosigma	3
Navicula	82
Nitzschia	62
Pleurosigma	6
Stauroneis	3
Surirella	32
Synedra	41



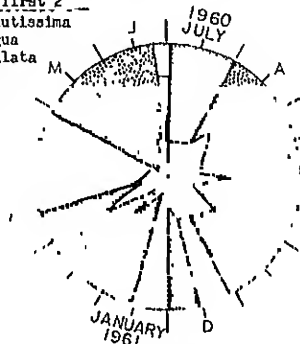
CHATTAHOOCHEE RIVER COLUMBUS, GEORGIA

Semi-monthly Samples
from July 1960 to July 1961



Others in first 4 species
but not in first 2 --

Achnanthes minutissima
Melosira ambigua
Melosira granulata
Nitzschia sp.
Pinnularia sp.
Synedra nana
Melosira sp.



DIATOMS - SPECIES DIVERSITY

FIRST 4 MOST ABUNDANT

ALL OTHER SPECIES

NO ANALYSIS MADE

ZOOPLANKTON

Samples analyzed 21
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers.	16	125.2
Keratella	15	25.6
Polyarthra	13	37.9
Brachionus	2	0.1
Synchaeta	4	2.2
Other genera	12	59.4
Crustaceans.		
nauplii	6	3.2
copepods	6	1.9
cladocerans	8	5.6
Nematodes		2.0
Other invertebrate metazoans	0	

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From October 1959 to May 1961

Blue-green algae	
Anacystis	3
Raphidiopsis	3
Green algae	
Scenedesmus	9
Green flagellates	
Chlamydomonas	9
Trachelomonas	0
Other pigmented flagellates	
Chromulina	10
Peridinium	3

Diatoms

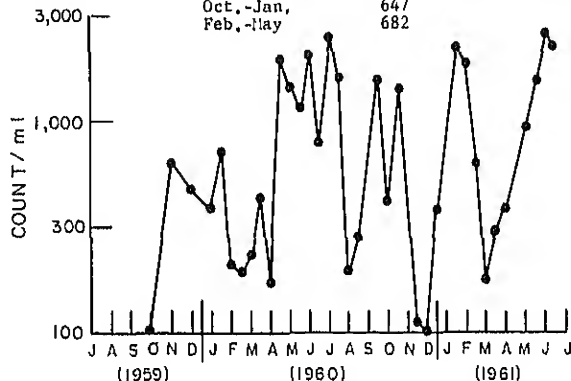
Centric	
Cyclotella	15
Melosira	15
Stephanodiscus	15

Pennate

Asterionella	3
Fragilaria	3
Nitzschia	6
Synedra	9

TOTAL LIVE PHYTOPLANKTON COUNTS

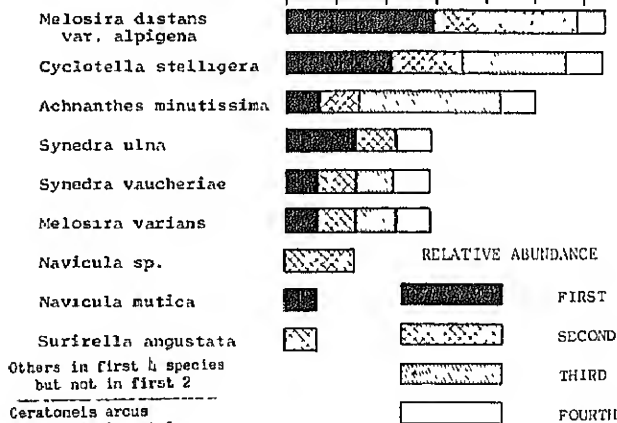
Months	Average count/ml.
June-Sept	1,310
Oct.-Jan.	647
Feb.-May	682



CHATTAHOOCHEE RIVER ATLANTA, GEORGIA

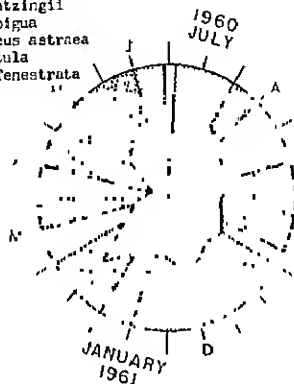
Semi-monthly Samples
from July 1960 to July 1961

DIATOMS - PERCENT OCCURRENCE

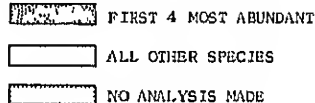


Others in first 4 species
but not in first 2

Ceratonella arcus
Cocconeis placentula
Cyclotella striata
Cymbella benticosa
Gyrosigma kutzingii
Melosira ambigua
Stephanodiscus astraea
var. minutula
Tabellaria fenestrata



DIATOMS - SPECIES DIVERSITY



ZOOPLANKTON

Samples analyzed 22
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers:	13	3.4
Keratella	8	1.1
Polyarthra	5	1.0
Brachionus	1	0
Synchaeta	2	0.1
Other genera	11	1.2
Crustaceans		
nauplii	3	0.3
copepods	0	0
cladocerans	3	0.3
Nematodes		0
Other invertebrate metazoans		0

MOST ABUNDANT
GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From June 1960 to June 1961

Green flagellates

Phacotus 4

Other pigmented flagellates

Chromulina 9

Diatoms

Centric

Cyclotella 18

Melosira 13

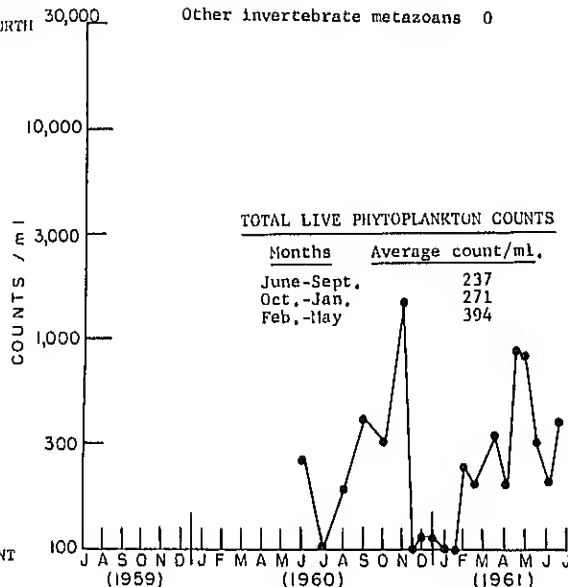
Stephanodiscus 4

Pennate

Asterionella 13

TOTAL LIVE PHYTOPLANKTON COUNTS

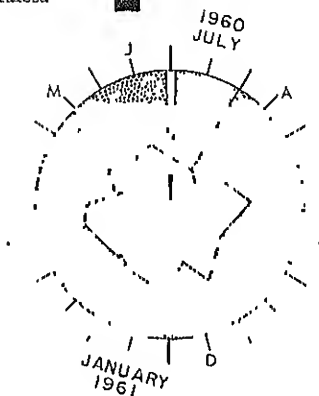
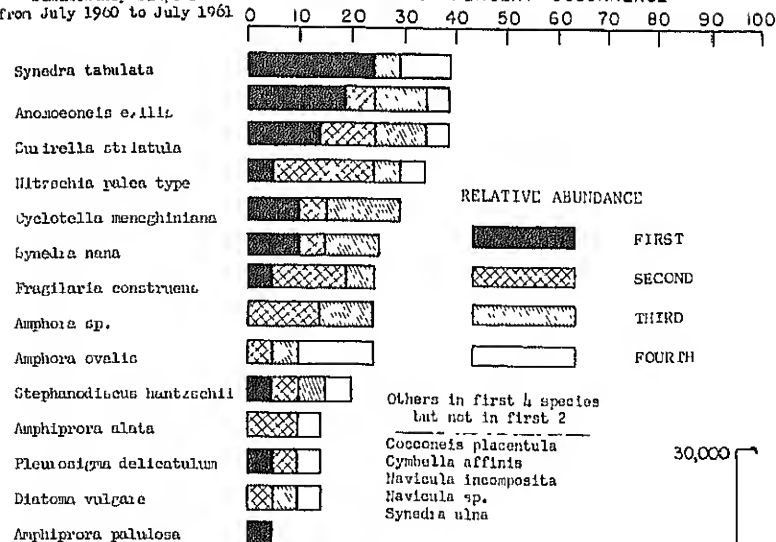
Months	Average count/ml.
June-Sept.	237
Oct.-Jan.	271
Feb.-May	394



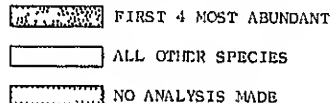
COLORADO RIVER YUMA, ARIZONA

Semimonthly Samples
from July 1960 to July 1961

DIATOMS - PERCENT OCCURRENCE



DIATOMS - SPECIES DIVERSITY



ZOOPLANKTON

Samples analyzed 23
July 1960 to July 1961

Samples with Animals	Average count per liter per sample
Rotifers:	9
Keratella	5
Polyarthra	3
Brachionus	5
Synchaeta	5
Other genera	7
Crustaceans:	
nauplii	7
copepods	5
cladocerans	2
Nematodes	2
Other invertebrate metazoans	0

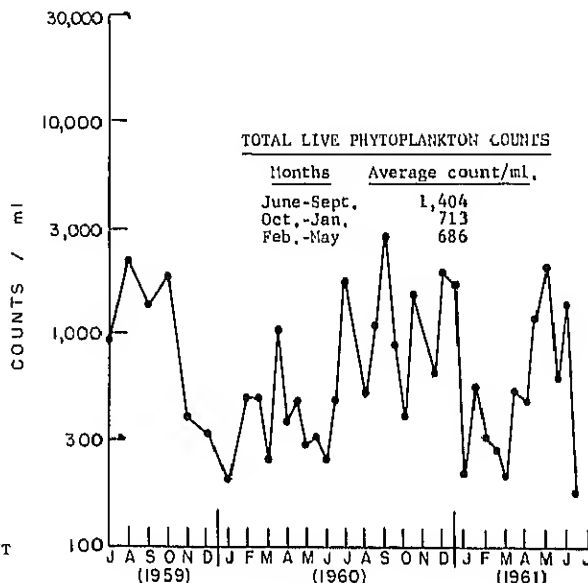
MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
from May 1959 to May 1961

Blue-green algae	
Anacystis	5
Gomphonema	3
Green algae	
Ankistrodesmus	3
Scenedesmus	5

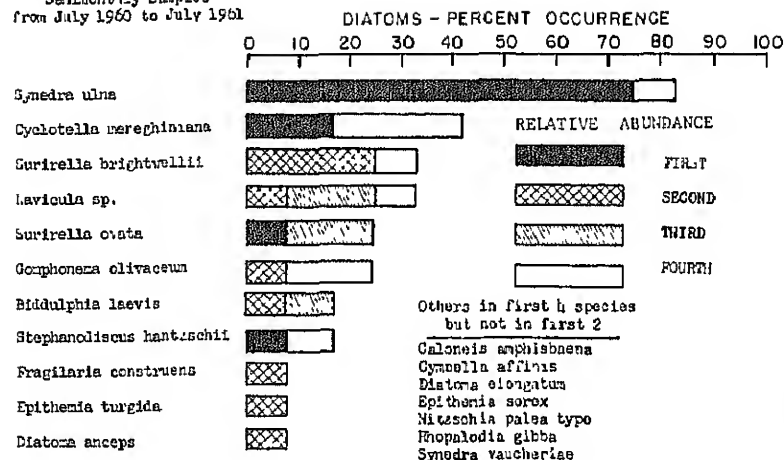
Diatoms	
Centric	
Cyclotella	16
Stephanodiscus	11

Pennate	
Amphora	8
Anomoeoneis	13
Fragilaria	8
Navicula	11
Nitroschia	11
Synedra	29



COLORADO RIVER PAGE, ARIZONA

Semimonthly Samples
from July 1960 to July 1961



ZOOPLANKTON

Samples analyzed 18
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers:	9	2.0
Keratella	5	0
Polyarthra	3	0
Brachionus	5	0.5
Synchaeta	5	2.0
Other genera	4	1.5
Crustaceans:		
nauplii	7	1.0
copepods	5	0
cladocerans	2	0
Nematodes		0
Other invertebrate metazoans		0

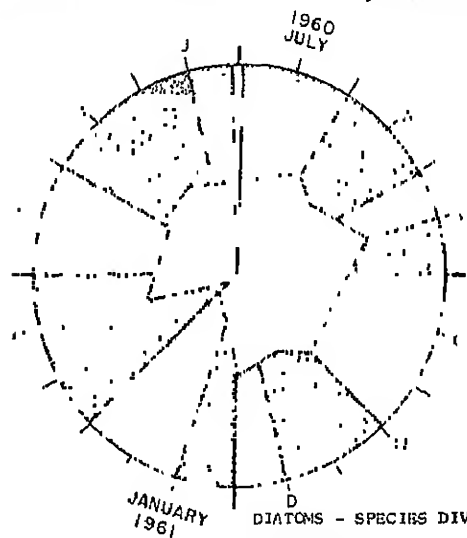
MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From Dec. 1959 to May 1961

Green Algae	
Ankistrodesmus	3
Scenedesmus	9
Green flagellates	
Chlamydomonas	6

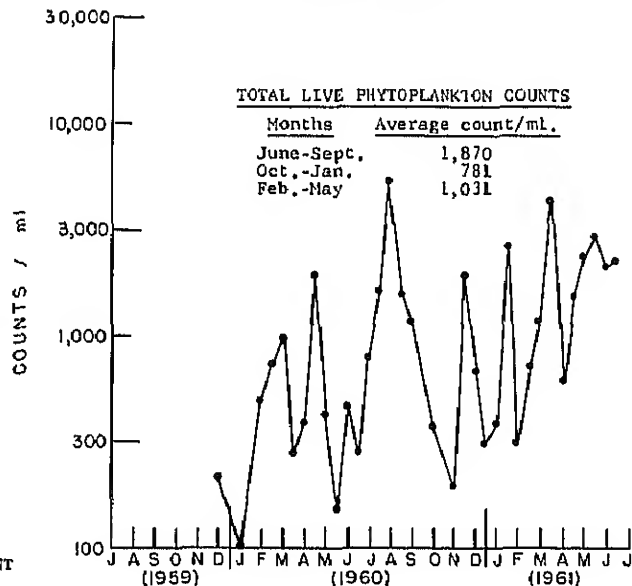
Diatoms	
Cyclotella	22
Stephanodiscus	19

Fernate	
Cymbella	6
Diatoma	6
Epithemia	3
Fragilaria	6
Gomphonema	3
Navicula	9
Nitzschia	12
Surirella	9
Synedra	38



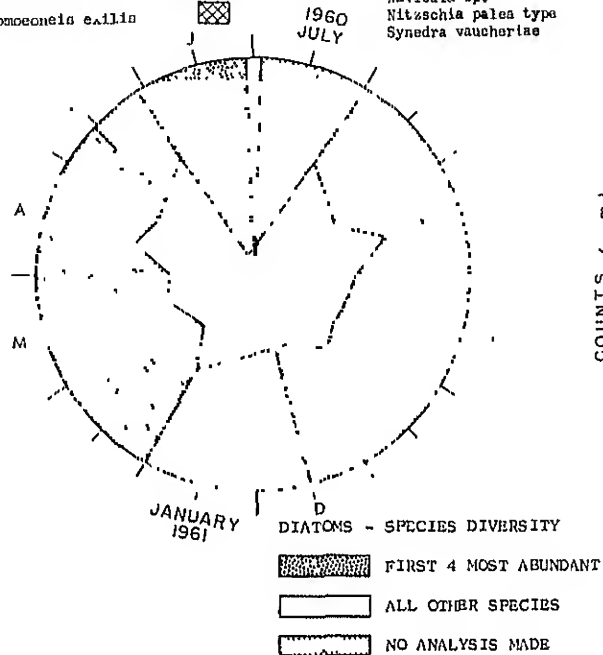
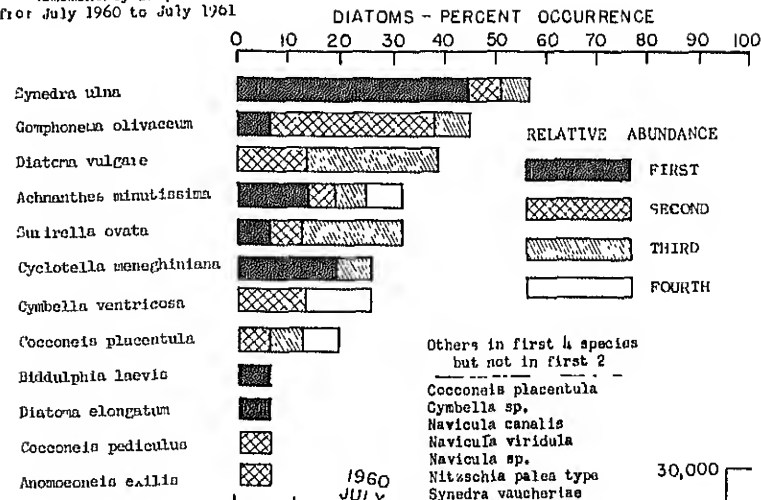
DIATOMS - SPECIES DIVERSITY

FIRST 4 MOST ABUNDANT
ALL OTHER SPECIES
NO ANALYSIS MADE



COLORADO RIVER LOMA, COLORADO

Semimonthly Samples
from July 1960 to July 1961



ZOOPLANKTON

Samples analyzed 19
July 1960 to July 1961

Samples with Animals	Average count per liter per sample
Rotifers:	6
Keratella	0
Polyarthra	0
Brachionus	0
Synchaeta	1
Other genera	3
Crustaceans:	
nauplii	0
copepods	0
cladocerans	0
Nematodes	1
Other invertebrate metazoans	0

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

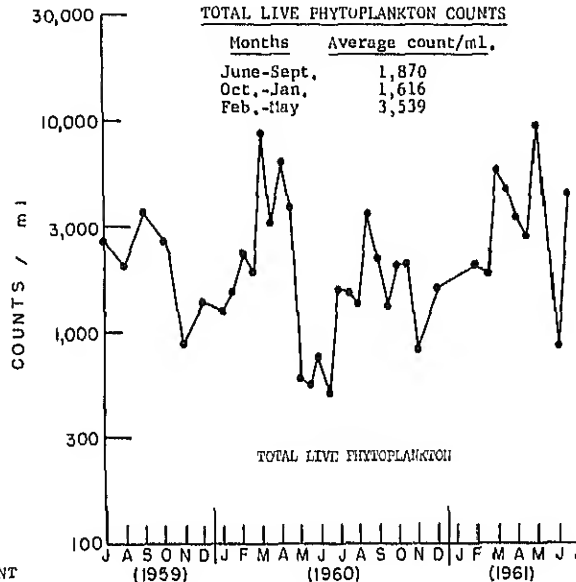
Blue-green algae
Anacystis 2

Green algae
Tetradismus 2

Diatoms
Centric
Cyclotella 30
Stephanodiscus 5

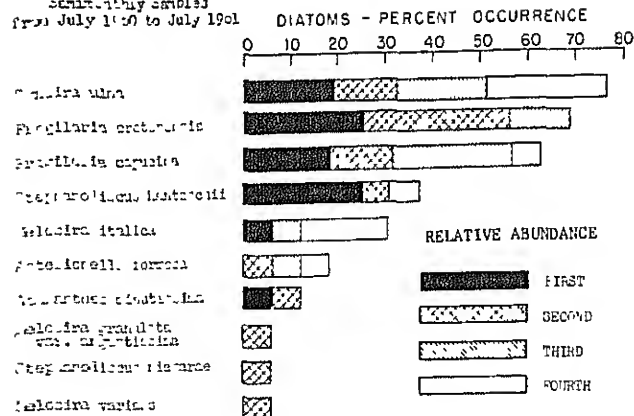
Pennate
Achnanthes 22
Cocconeis 15
Cymbella 52
Diatoma 36
Fragilaria 2
Gomphonema 52
Navicula 69
Nitzschia 16
Surirella 19
Synedra 75
Stauroneis 2
Opephora 2

TOTAL LIVE PHYTOPLANKTON COUNTS



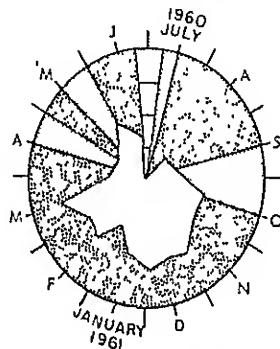
COLUMBIA RIVER CLATSKANIE, OREGON

Semi-monthly Samples
from July 1960 to July 1961



Others in first 4 species
but not in first 2

Fragilaria construens
Melosira ambigua
Melosira granulata
Stephanodiscus astraea var. *minutula*
Synedra sp.



DIATOMS - SPECIES DIVERSITY

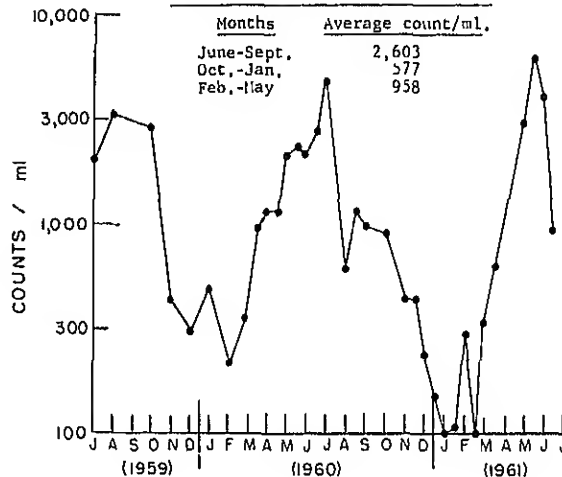
FIRST 4, MOST ABUNDANT
ALL OTHER SPECIES
NO ANALYSIS MADE

ZOOPLANKTON

Samples analyzed 22
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers.	13	46.8
Keratella	11	23.0
Polyarthra	9	12.0
Brachionus	5	2.7
Synchaeta	7	0.6
Other genera	6	8.5
Crustaceans		
nauplii	7	1.0
copepods	8	0.6
cladocerans	8	1.0
Nematodes		0
Other invertebrate metazoans		0

TOTAL LIVE PHYTOPLANKTON COUNTS



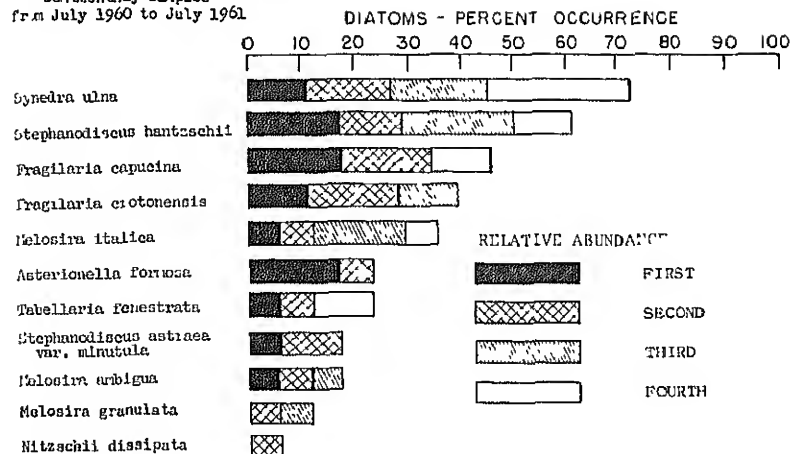
MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Blue-green algae	
Anacystis	3
Phormidium	3
Green algae	
chlorella-type	3
Stichococcus	6
Diatoms	
Cenchrus	
Cyclotella	19
Melosira	32
Stephanodiscus	31
Pennate	
Achnanthes	6
Asterionella	19
Fragilaria	25
Navicula	9
Synedra	19
Tabellaria	6

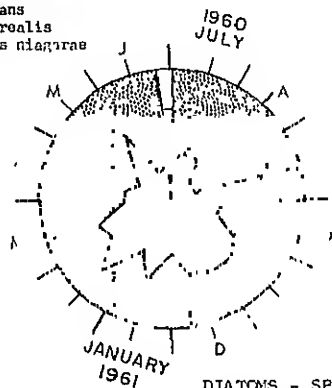
COLUMBIA RIVER BONNEVILLE, OREGON

Semi-monthly Samples
from July 1960 to July 1961



Others in first 4 species
but not in first 2

Achnanthes minutissima
Melosira varians
Pinnularia borealis
Stephanodiscus niagarae
Synedra acus



DIATOMS - SPECIES DIVERSITY

FIRST 4 MOST ABUNDANT

ALL OTHER SPECIES

NO ANALYSIS MADE

ZOOPLANKTON

Samples analyzed 21
July 1960 to July 1961

Samples
with
Animals

Average count
per liter/sample

Rotifers	10	18.9
Keratella	10	12.0
Polyarthra	6	3.0
Brachionus	4	0.8
Synchaeta	2	0.6
Other genera	8	3.3
Crustaceans:		
nauplii	3	0
copepods	2	0
cladocerans	2	0
Other invertebrate metazoans	0	

MOST ABUNDANT GENERA OF ALGAE

Incident frequency of counts

150 per ml. or more

from May 1959 to May 1961

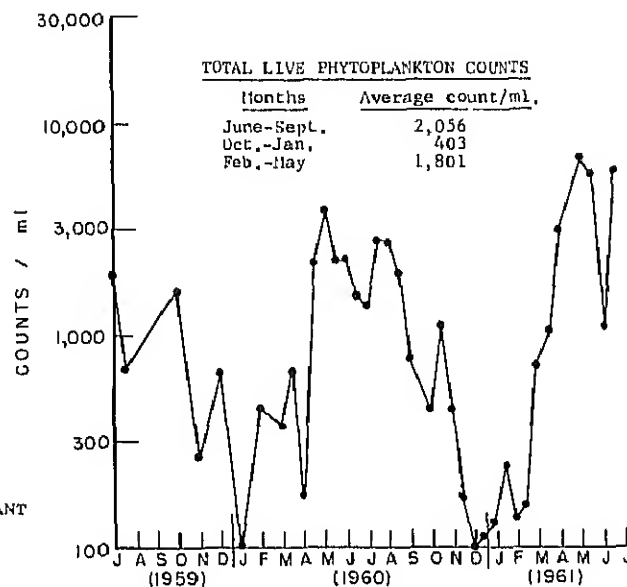
Blue-green algae	
Anacystis	3
Phormidium	6

Diatoms

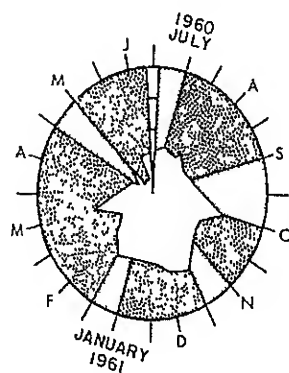
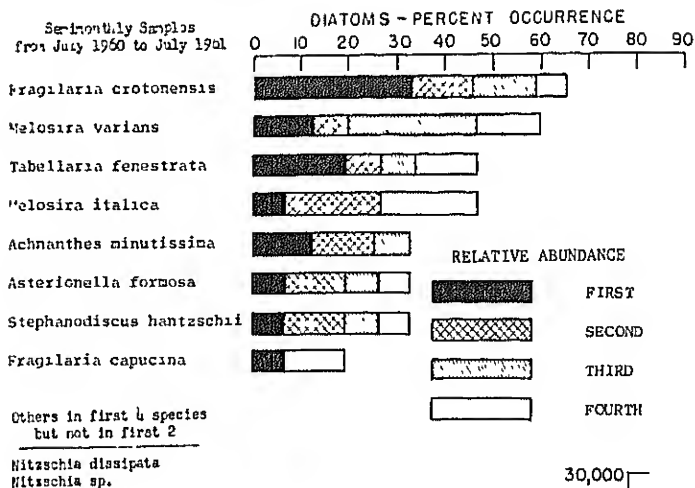
Cyclotella	23
Melosira	26
Stephanodiscus	29

Pennate

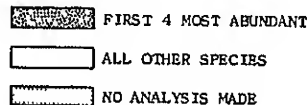
Achnanthes	3
Asterionella	31
Diatoma	3
Fragilaria	39
Navicula	11
Nitzschia	6
Synedra	29
Tabellaria	11



COLUMBIA RIVER PASCO, WASHINGTON



DIATOMS - SPECIES DIVERSITY



ZOOPLANKTON

Samples analyzed 19
July 1960 to July 1961

Samples
with
Animals

Average count
per
liter
per sample

Rotifers.	14	3.9
Keratella	6	0.8
Polyarthra	7	1.0
Brachionus	2	0
Synchaeta	3	3.9
Other genera	8	3.1
Crustaceans.		
nauplii	2	0
copepods	2	0
cladocerans	1	0
Nematodes		0
Other invertebrate metazoans		0

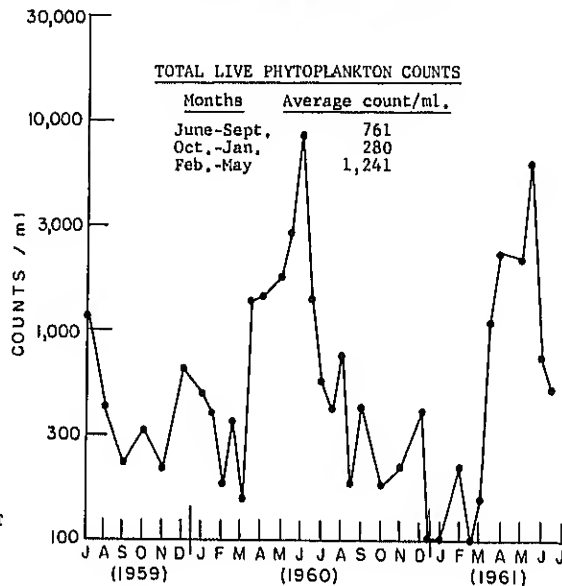
MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Blue-green algae
Phormidium 3

Diatoms
Centric
Cyclotella 6
Melosira 31
Stephanodiscus 11

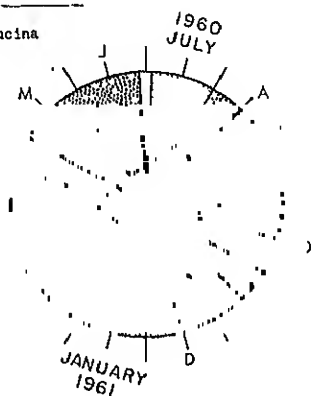
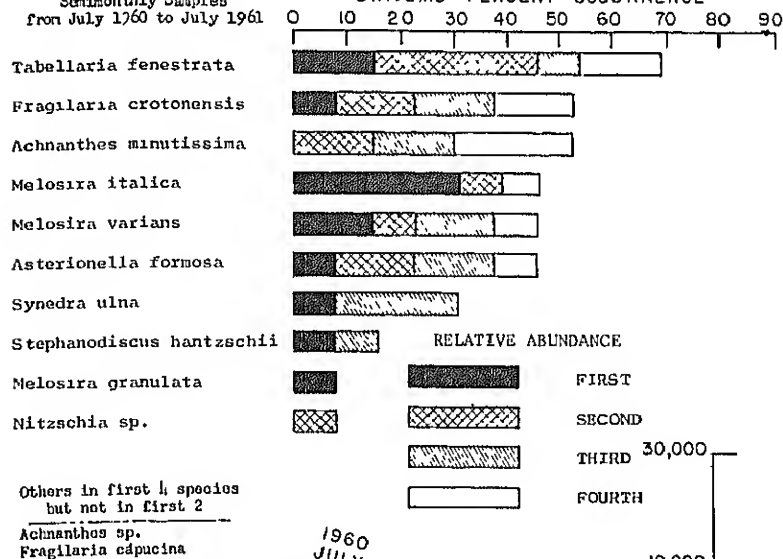
Pennate
Achnanthes 9
Asterionella 31
Fragilaria 14
Nitzschia 9
Synedra 23
Tabellaria 34



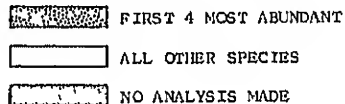
COLUMBIA RIVER WENATCHEE, WASHINGTON

Semimonthly Samples
from July 1960 to July 1961

DIATOMS - PERCENT OCCURRENCE



DIATOMS - SPECIES DIVERSITY



ZOOPLANKTON

Samples analyzed 17
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers:	8	3.7
Keratella	6	1.7
Polyarthra	1	0
Brachionus	0	0
Synchaeta	1	0
Other genera	8	2.7
Crustaceans:		
nauplii	1	0
copepods	0	0
cladocerans	2	0
Nematodes		0
Other invertebrate metazoans		0

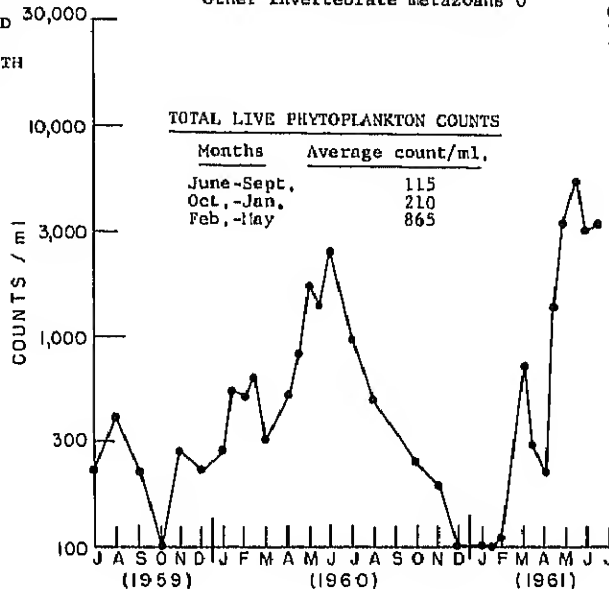
MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

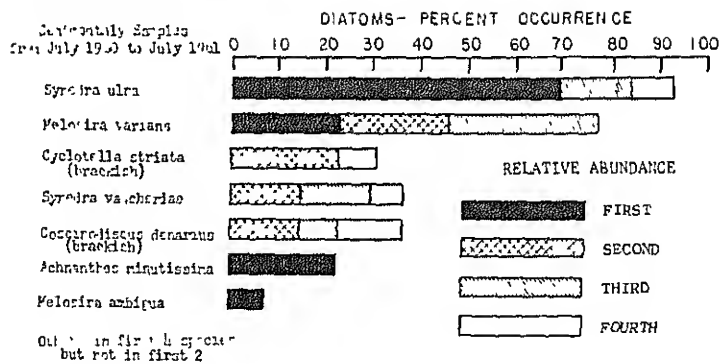
Diatoms	
Centric	
Cyclotella	7
Melosira	10
Pennate	
Achnanthes	10
Asterionella	31
Fragilaria	7
Nitzschia	3
Synedra	14
Tabellaria	45

TOTAL LIVE PHYTOPLANKTON COUNTS

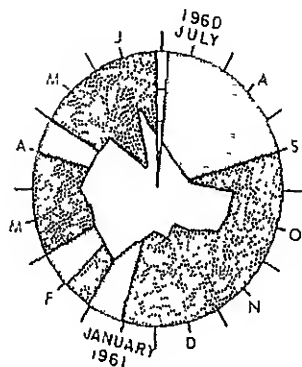
Months	Average count/ml.
June-Sept.	115
Oct.-Jan.	210
Feb.-May	865



DELAWARE RIVER PHILADELPHIA, PA



Asterionella formosa
Cyclotella renaphimiana
Cocconeis placentula
Nitzschia taenioides type



ZOOPLANKTON

Samples analyzed 18
July 1960 to July 1961

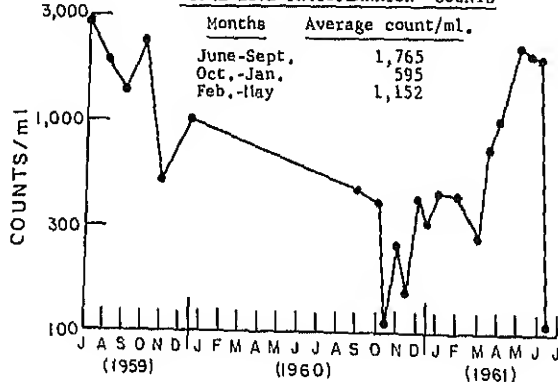
Samples with Animals	Average count per liter per sample
Rotifers.	6
Keratella	2
Polyarthra	1
Brachionus	1
Synchaeta	1
Other genera	5
Grustaceans.	
nauplii	0
copepods	0
cladocerans	0
Nematodes	1.0
Other invertebrate metazoans	0

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
from May 1957 to May 1961

Blue-green algae	
Anaesthia	14
Green algae	
Actinostichum	3
Ankistrodesmus	3
Chlorocella-type	3
Cocystis	3
Scenedesmus	14
Green flagellates	
Chlamydomonas	3
Other pigmented flagellates	
Ceramion	3
Diatoms	
Centric	
Cyclotella	33
Melosira	10
Pennate	
Asterionella	5
Fragilaria	5
Gomphonema	5
Navicula	5
Synedra	52

TOTAL LIVE PHYTOPLANKTON COUNTS

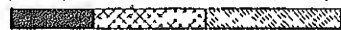


DELAWARE RIVER MARTINS CREEK, PENNSYLVANIA

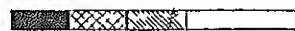
Seminomthly Samples
from July 1960 to July 1961

DIATOMS - PERCENT OCCURRENCE
0 10 20 30 40 50 60 70

Achnanthes minutissima



Melosira varians



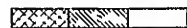
Synedra vaucheriae



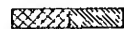
Diatoma vulgare



Cymbella ventricosa



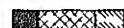
Synedra ulna



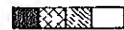
Asterionella formosa



Ceratoneis arcus



Nitzschia palea type



Cocconeis placentula



Achnanthes sp.



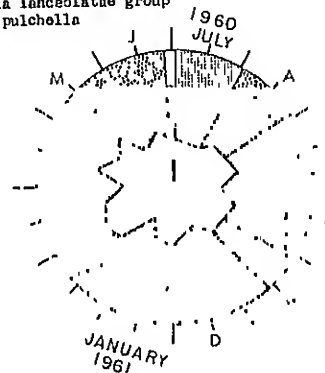
Others in first 4 species
but not in first 2

Navicula cryptocephala

Navicula tripunctata

Nitzschia lanceolata group

Synedra pulchella



DIATOMS - SPECIES DIVERSITY

FIRST 4 MOST ABUNDANT

ALL OTHER SPECIES

NO ANALYSIS MADE

ZOOPLANKTON

Samples analyzed 23
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers:	16	6.3
Keratella	10	1.6
Polyarthra	5	0.4
Brachionus	1	0
Synchaeta	5	0.4
Other genera	12	3.9
Crustaceans:		
nauplii	2	0.1
copepods	3	0.1
cladocerans	1	0.1
Nematodes	2	
Other invertebrate metazoans	0	

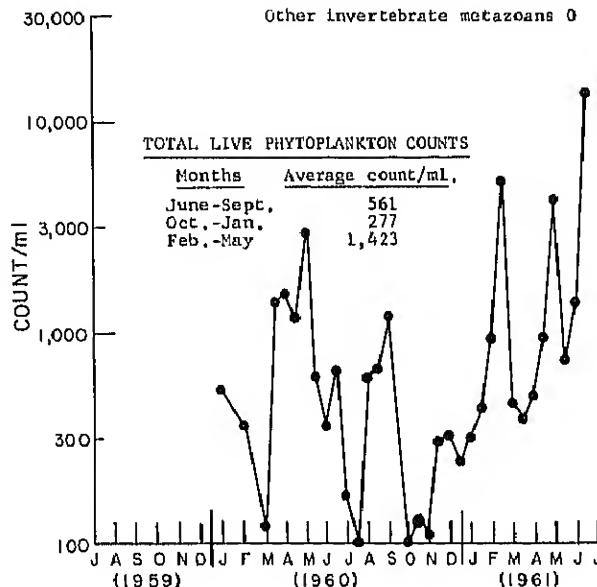
MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Green algae	
Scenedesmus	6
Green flagellates	
Chlamydomonas	3
Chlorobrachis	3
Other pigmented flagellates	
Chromulina	3
Diatoms	
Centric	
Cyclotella	6
Melosira	9
Stephanodiscus	3
Pennate	
Achnanthes	6
Asterionella	16
Ceratoneis	6
Cocconeis	3
Cymbella	13
Diatoma	16
Fragilaria	6
Navicula	6
Nitzschia	3
Synedra	25

TOTAL LIVE PHYTOPLANKTON COUNTS

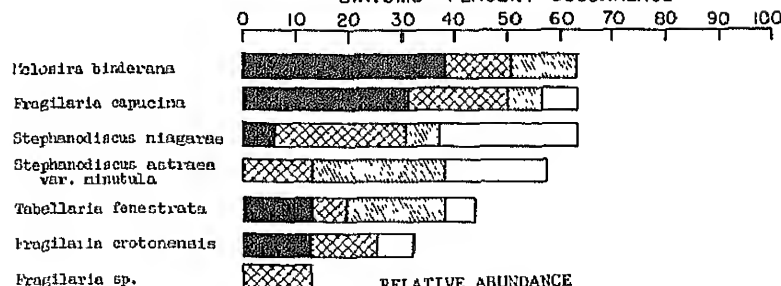
Months	Average count/ml.
June-Sept.	561
Oct.-Jan.	277
Feb.-May	1,423



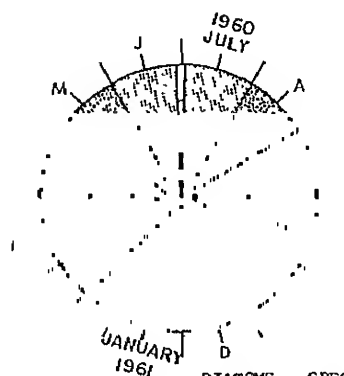
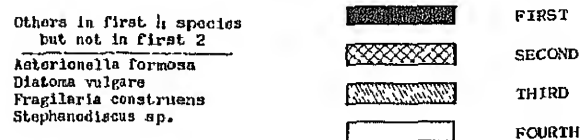
GREAT LAKES, LAKE ERIE, NIAGARA RIVER BUFFALO, NEW YORK

Seminmonthly Samples
from July 1960 to July 1961

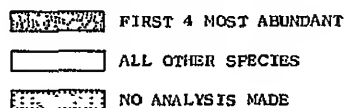
DIATOMS - PERCENT OCCURRENCE



RELATIVE ABUNDANCE



DIATOMS - SPECIES DIVERSITY



ZOOPLANKTON

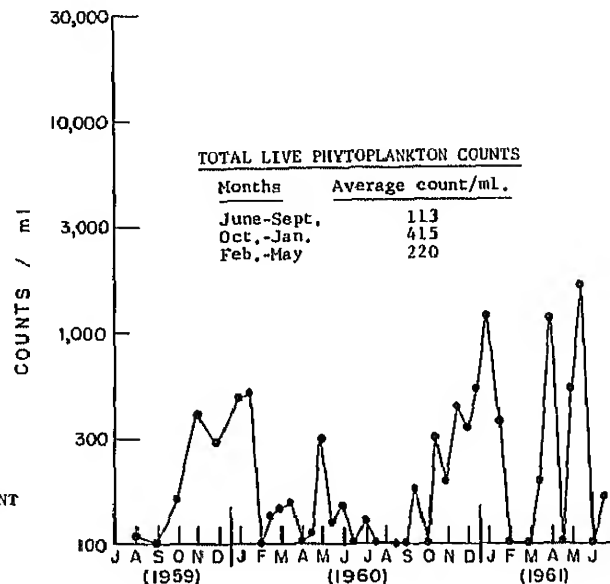
Samples analyzed 23
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers	23	66.1
Keratella	23	27.5
Polyarthra	20	30.0
Brachionus	4	0.6
Synchaeta	5	1.0
Other genera	18	6.9
Crustaceans:		
nauplii	11	4.5
copepods	11	3.5
cladocerans	10	4.9
Nematodes		1.0
Other invertebrate metazoans		0

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

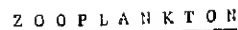
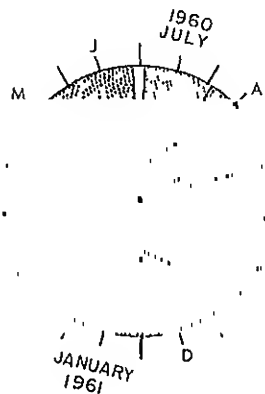
Diatoms	
Centric	
Cyclotella	5
Melosira	7
Stephanodiscus	17
Pennate	
Asterionella	2
Diatoma	2



TOTAL LIVE PHYTOPLANKTON COUNTS

Months	Average count/ml.
June-Sept.	113
Oct.-Jan.	415
Feb.-May	220

Semimonthly Samples
from July 1960 to July 1961



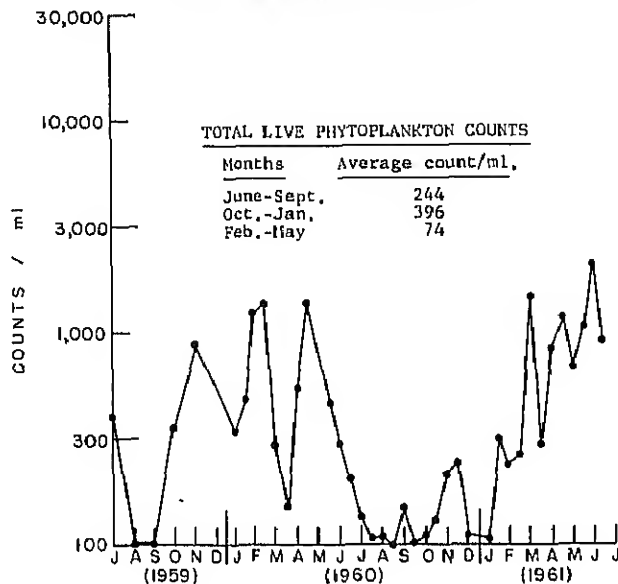
Samples analyzed 23
July 1960 to July 1961

MOST ABUNDANT
GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
from May 1959 to May 1961

Diatoms	
Centric	
Cyclotella	5
Stephanodiscus	5

Pennate	
Asterionella	17
Diatoms	17
Fragilaria	12
Synedra	12
Tabellaria	10

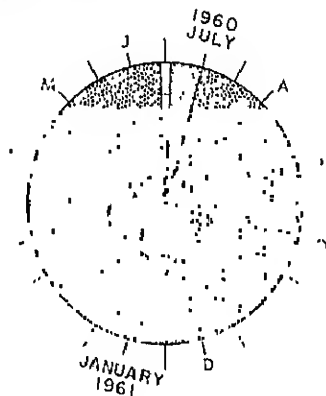
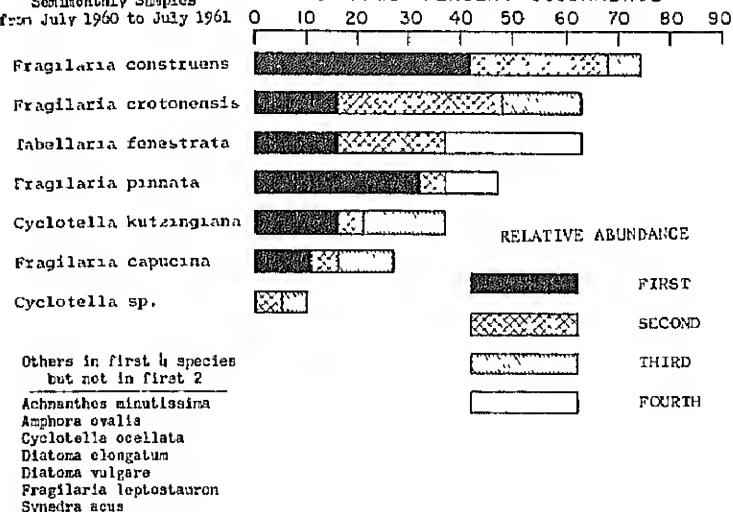


GREAT LAKES, LAKE HURON, ST CLAIR RIVER PORT HURON, MICHIGAN

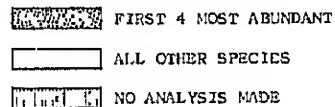
ZOOPLANKTON

Semi-monthly Samples
from July 1960 to July 1961

DIATOMS - PERCENT OCCURRENCE



DIATOMS - SPECIES DIVERSITY



Samples analyzed 24
July 1960 to July 1961

Samples with Animals Average count per liter per sample

Rotifers:	20	22.2
Keratella	14	12.0
Polyarthra	9	4.5
Brachionus	5	0.5
Synchaeta	4	0.5
Others	16	4.7

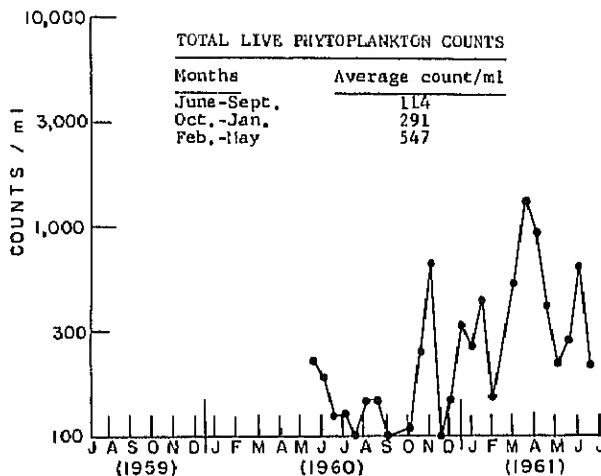
Crustacea:		
Nauplii	11	2.3
Copepods	16	6.1
Cladocera	11	2.3

Other invertebrate metazoans 0

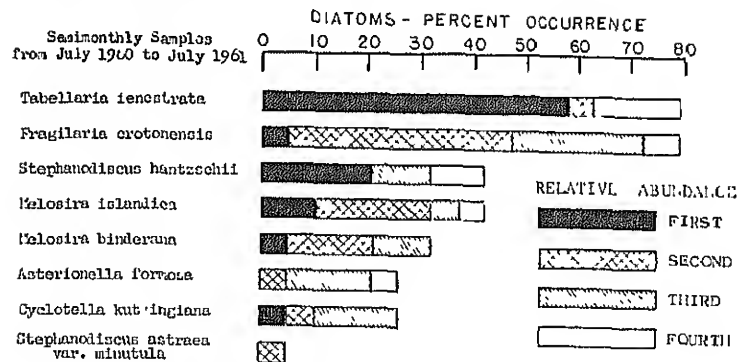
MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1960 to May 1961

Diatoms	
Centric	
Cyclotella	4
Stephanodiscus	4
Pennate	
Asterionella	8
Diatoma	4
Fragilaria	13

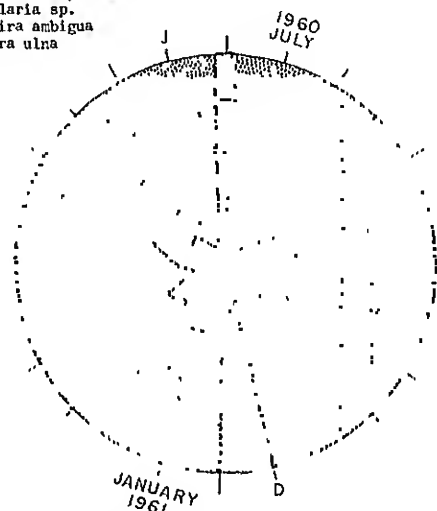


GREAT LAKES, LAKE MICHIGAN GARY, INDIANA



Others in first 4 species but not in first 2

Cyclotella comta
Diatoma vulgare
Fragilaria capucina
Fragilaria sp.
Melosira ambigua
Synedra ulna



ZOOPLANKTON

Samples analyzed 21
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers:	17	16.2
Keratella	11	6.8
Polyarthra	5	0.7
Brachionus	5	1.6
Synchaeta	2	0
Other genera	15	7.1
Crustaceans:		
nauplii	6	0
copepods	7	0
cladocerans	6	2.7
Nematodes		0
Other invertebrate metazoans		0

MOST ABUNDANT GENERA OF ALGAE

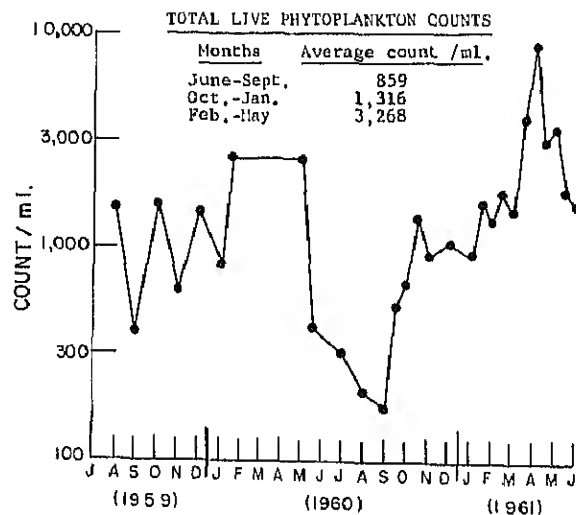
Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Blue-green algae
Anacystis 3

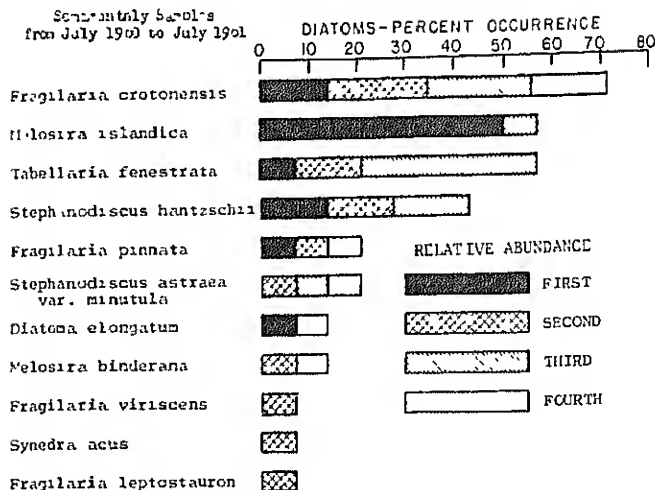
Green algae
Cocystis 3

Diatoms
Centric
Cyclotella 25
Melosira 56
Rhizosolenia 3
Stephanodiscus 21

Fennate
Asterionella 14
Diatoma 3
Fragilaria 18
Nitzschia 3
Synedra 32
Tabellaria 54

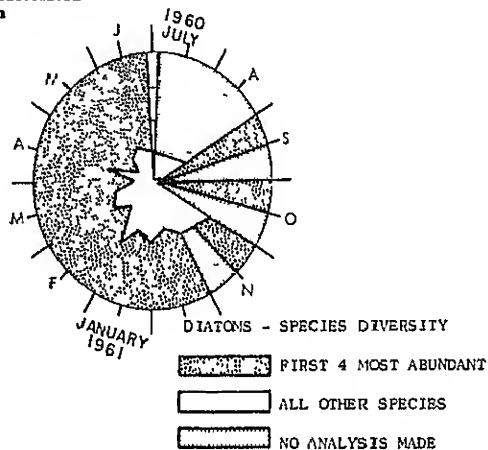


GREAT LAKES, LAKE MICHIGAN MILWAUKEE, WISCONSIN



Others in first 4 species
but not in first 2

Asterionella formosa
Cyclotella comta
Cyclotella kuetzingiana
Fragilaria capucina
Stephanodiscus "michiganiana"
Tabellaria flocculosa
Synedra ulna



ZOOPLANKTON

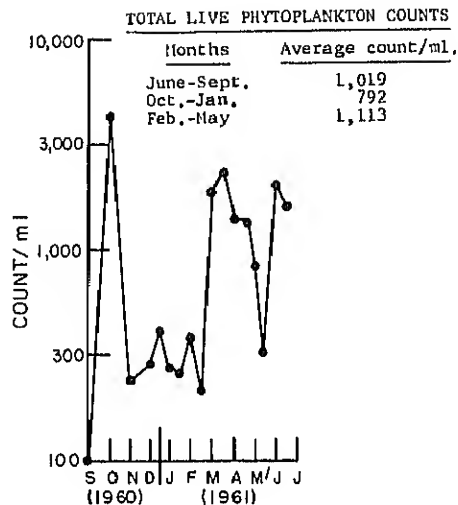
Samples analyzed 19
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers:	16	8.3
Keratella	11	2.2
Polyarthra	5	2.2
Brachionus	8	1.1
Synchaeta	4	0.7
Other genera	13	2.1
Crustaceans		
nauplii	9	2.1
copepods	13	2.9
cladocerans	6	0.8
Nematodes		0
Other invertebrate metazoans		0.8

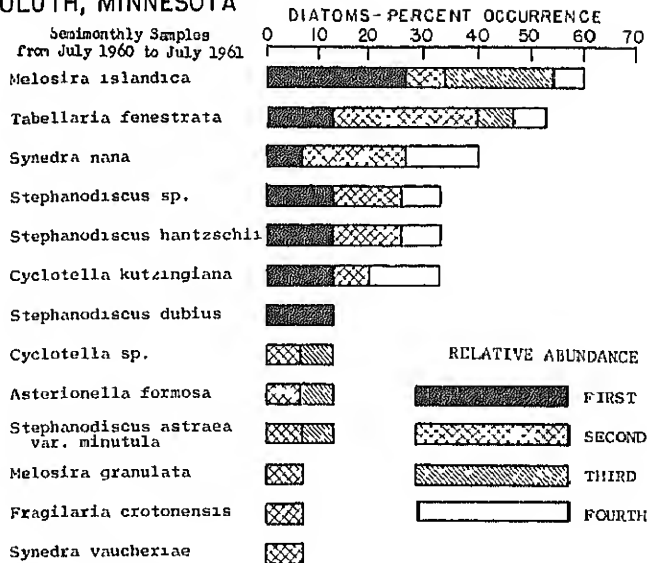
MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From Sept. 1960 to Sept. 1961

Diatoms	
Centric	
Cyclotella	15
Melosira	15
Stephanodiscus	55
Pennate	
Fragilaria	10
Synedra	20
Tabellaria	10

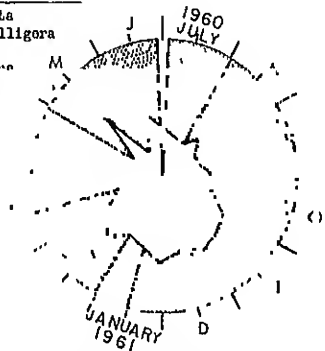


GREAT LAKES, LAKE SUPERIOR
DULUTH, MINNESOTA






Others in first 4 species
but not in first 2

Cyclotella comta
Cyclotella stelligera
Fragilaria sp.
Melosira ambigua
Rhizosolenia
Synedra acus
Synedra sp.



DIATOMS - SPECIES DIVERSITY

 FIRST 4 MOST ABUNDANT
 ALL OTHER SPECIES
 NO ANALYSIS MADE

ZOOPLANKTON

Samples analyzed 24
July 1960 to July 1961

Samples with Animals	Average count per liter per sample
----------------------------	--

Rotifers:	8	1.3
Keratella	8	0.3
Polyarthra	1	0
Brachionus	0	0
Synchaeta	2	0.2
Others	5	0.8

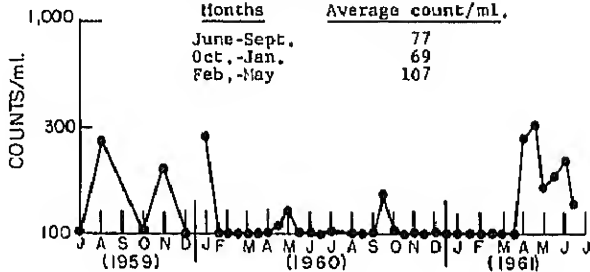
Crustaceans:		
nauplii	3	0.3
copepods	4	0.3
cladocerans	2	0.2




Other invertebrate metazoans 0

THERE WERE NO GENERA OF
ALGAE WITH COUNTS OVER
150 per ml.

TOTAL LIVE PHYTOPLANKTON COUNTS

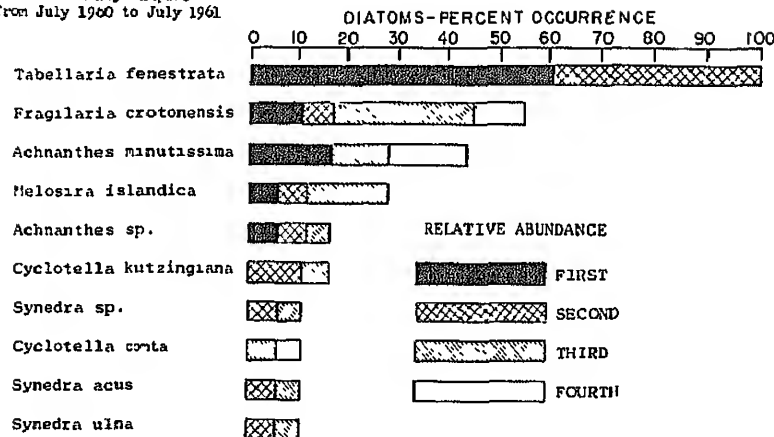
<u>Months</u>	<u>Average count/ml.</u>
June-Sept.	77
Oct. -Jan.	69
Feb. -May	107



 FIRST 4 MOST ABUNDANT
 ALL OTHER SPECIES
 NO ANALYSIS MADE

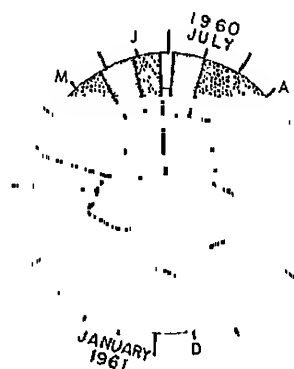
GREAT LAKES, LAKE SUPERIOR, ST MARY'S RIVER
SAULT STE. MARIE, MICHIGAN

Seventeenthly Samples
from July 1960 to July 1961

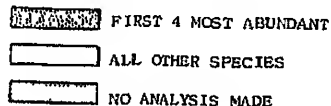


Others in first 4 species
but not in first 2

Amphiphora ovalis
Asterionella formosa
Coscinodiscus placentula
Cyclotella glomerata
Cyclotella sp.
Cymbella sp.
Fragilaria construens
Rhizosolenia eriensis
Stephanodiscus hantzschii
Synedra nana
Synedra sp.



DIATOMS - SPECIES DIVERSITY



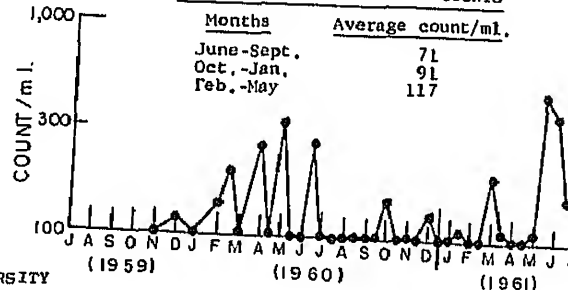
THERE WERE NO GENERA OF
ALGAE WITH COUNTS OVER
150 per ml.

ZOOPLANKTON

Samples analyzed 23
July 1960 to July 1961

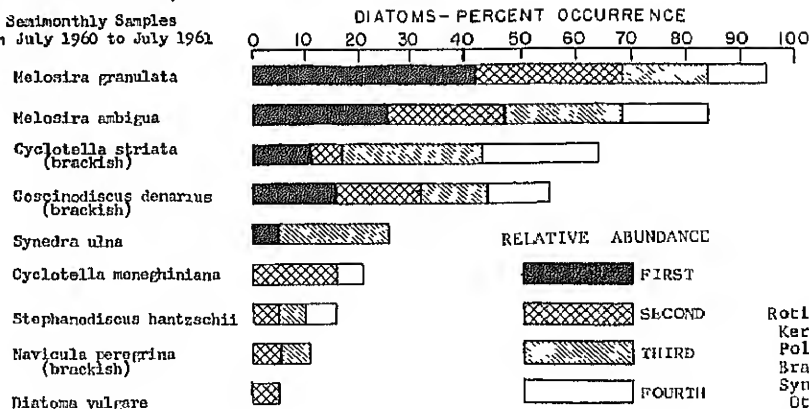
Samples with Animals	Average count per liter per sample
Rotifers: 15	7.7
Keratella 14	2.3
Polyarthra 6	1.3
Brachionus 3	0.1
Synchaeta 4	0.4
Other genera 9	4.4
Crustaceans:	
nauplii 5	0.9
copepods 6	0.9
cladocerans 3	0.2
Other invertebrate metazoa 0	

TOTAL LIVE PHYTOPLANKTON COUNTS



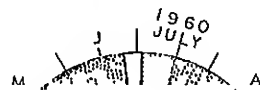
HUDSON RIVER POUGHKEEPSIE, NEW YORK

Semi-monthly Samples
from July 1960 to July 1961



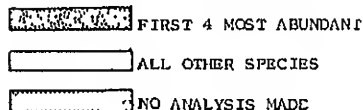
Others in first 4 species
but not in first 2

Melosira distans var. alpicornis
Melosira varians



JANUARY 1961

DIATOMS - SPECIES DIVERSITY



ZOOPLANKTON

Samples analyzed 22
July 1960 to July 1961

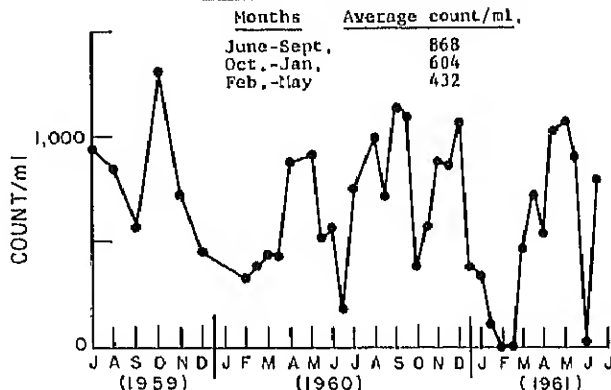
	Samples with Animals	Average count per liter per sample
Rotifers	17	8.0
Keratella	12	2.1
Polyarthra	3	0.2
Brachionus	4	0.2
Synchaeta	2	0.1
Other genera	14	5.4
Crustaceans:		
nauplii	7	0.6
copepods	5	0.6
cladocerans	5	0.6
Nematodes		2
Other invertebrate metazoans	0	

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Blue-green algae	
Anacystis	3
Green algae	
Scenedesmus	6
Tetrastrum	3
Diatoms	
Centric	
Coscinodiscus	6
Cyclotella	26
Melosira	31
Stephanodiscus	3
Pennate	
Synedra	9

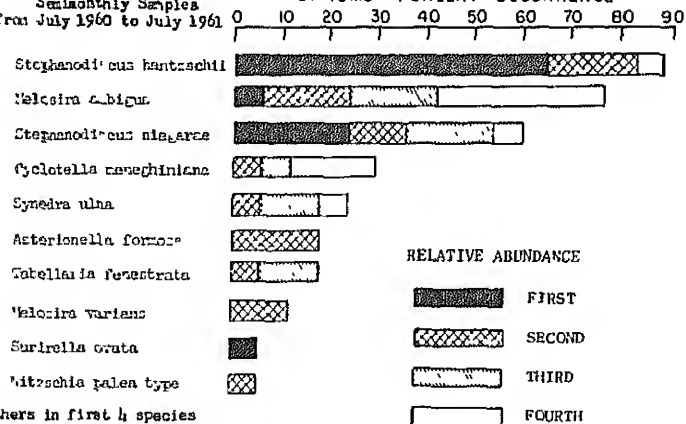
TOTAL LIVE PHYTOPLANKTON COUNTS



ILLINOIS RIVER PEORIA, ILLINOIS

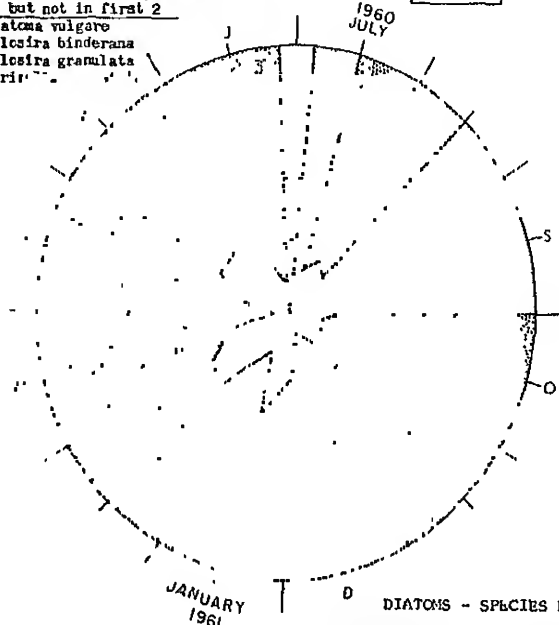
Semi-monthly Samples
from July 1960 to July 1961

DIATOMS - PERCENT OCCURRENCE



Others in first 4 species
but not in first 2

Diatoma vulgare
Melosira binderana
Melosira granulata
Surirella



FIRST 4 MOST ABUNDANT

ALL OTHER SPECIES

NO ANALYSTIC MAPS

ZOOPLANKTON

Samples analyzed 21
July 1960 to July 1961

Samples with Animals Average count per liter per sample

Rotifers.	19	242.2
Keratella	14	84.
Polyarthra	13	52.
Brachionus	4	33.
Synchaeta	12	11.
Other genera	17	85.

Crustaceans:		
nauplii	10	23.
copepods	8	7.
cladocerans	3	4.

Nematodes		2.
Other invertebrate metazoans		0

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From March 1960 to May 1961

Blue-green algae	
Anacystis	8
Thormidium	4

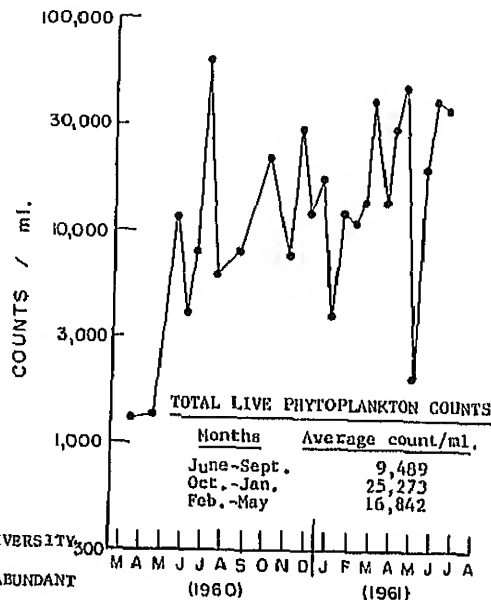
Green algae	
Actinostrium	33
Ankistrodesmus	22
Chlorocella-type	8
Chlorococcum	4
Golenkinia	13
Micractinium	8
Scenedesmus	38
Monella	4

Green flagellates	
Chlamydomonas	79
Hydrocolea	13
Gonium	4
Lepidodermis	8
Trachelomonas	46

Other pigmented flagellates	
Phaeocystis	33

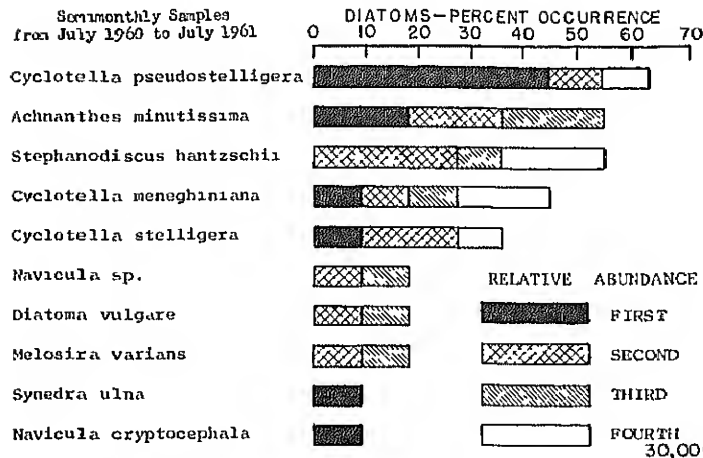
Diatoms	
Centric	
Cyclotella	50
Melosira	42
Stephanodiscus	92

Pennate	
Asterionella	25
Diatoma	13
Flagellaria	4
Gomphonema	4
Myricella	13
Nitroschia	50
Surirella	8
Synedra	33



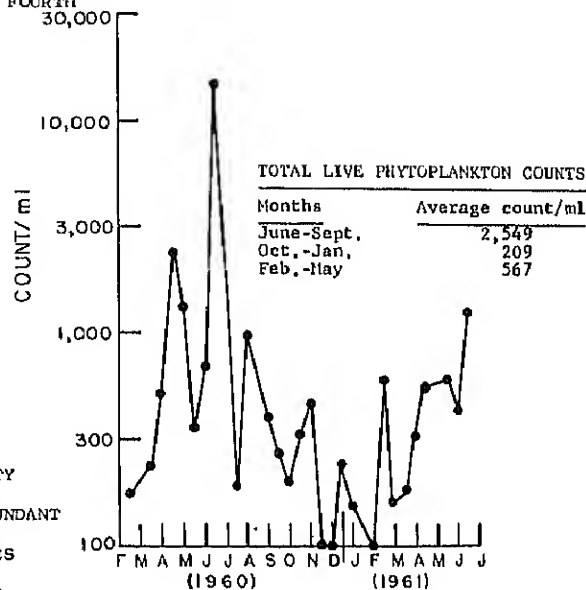
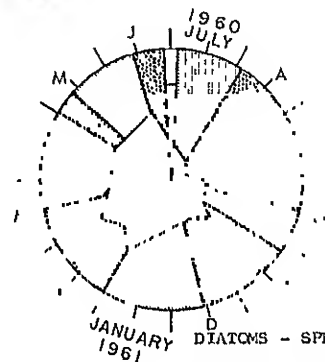
KANAWHA RIVER WINFIELD DAM, WEST VIRGINIA

Semimonthly Samples
from July 1960 to July 1961



Others in first 4 species
but not in first 2

Fragilaria crotonensis
Nitzschia palea type
Synedra vaucheriae



ZOOPLANKTON

Samples analyzed 21
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers.	5	6.1
Keratella	1	0.1
Polyarthra	1	0.1
Brachionus	2	0.1
Synchaeta	0	0
Others	2	5.8
Crustacea:		
Nauplii	0	0
Copepods	0	0
Gladocera	0	0
Nematodes		1
Other invertebrate metazoans		0

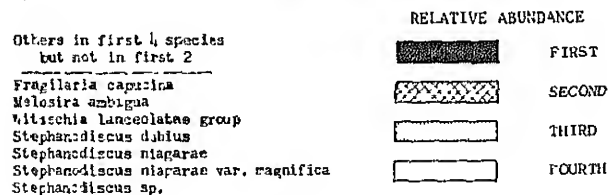
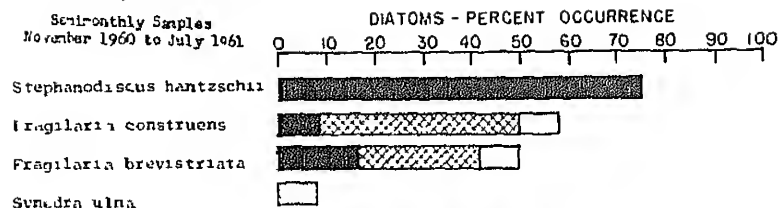
MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From February 1960 to May 1961

Green algae	
Ankistrodesmus	7
Chlorococcum	3
Scenedesmus	3
Stigeoclonium	3
Green flagellates	
Chlamydomonas	11
Other pigmented Flagellates	
Chromulina	3
Diatoms	
Centric	
Cyclotella	15
Stephanodiscus	7

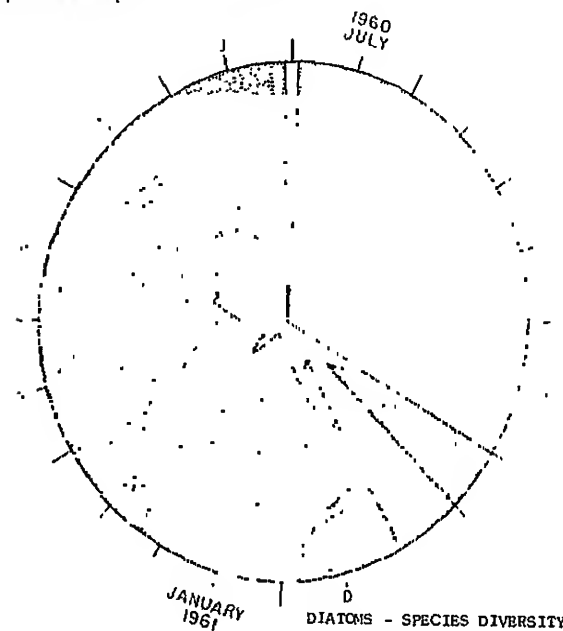
KLAMATH RIVER KENO, OREGON

Seemonthly Samples
November 1960 to July 1961



Others in first 4 species
but not in first 2

Fragilaria capricornis
Melosira ambigua
Nitzschia lanceolata group
Stephanodiscus diadema
Stephanodiscus niagarae
Stephanodiscus niagarae var. magnifica
Stephanodiscus sp.



DIATOMS - SPECIES DIVERSITY

FIRST 4 MOST ABUNDANT

ALL OTHER SPECIES

ZOOPLANKTON

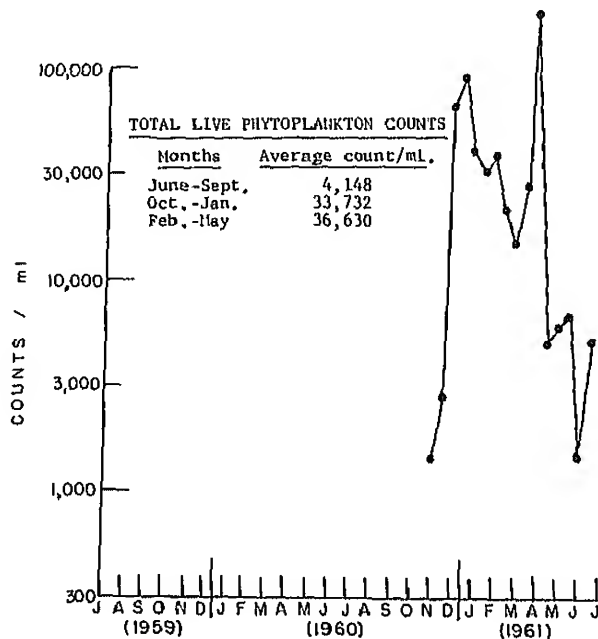
Samples analyzed 18
Nov. 1960 to August 1961

	Samples with Animals	Average count per liter per sample
ROTIFERS	18	161.3
Keratella	17	39.8
Polyarthra	13	39.8
Brachionus	14	28.2
Synchaeta	10	2.1
Other genera	15	51.4
Crustaceans, nauplii	8	7.8
copepods	7	2.9
cladocerans	4	2.3
Nematodes	0	0
Other invertebrate metazoans	0	0

MOST ABUNDANT GENERA OF ALGAE

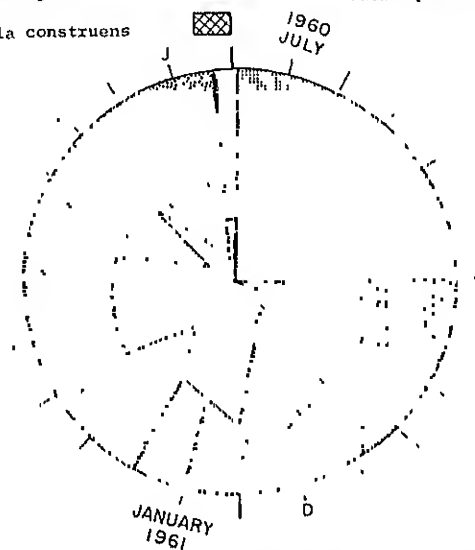
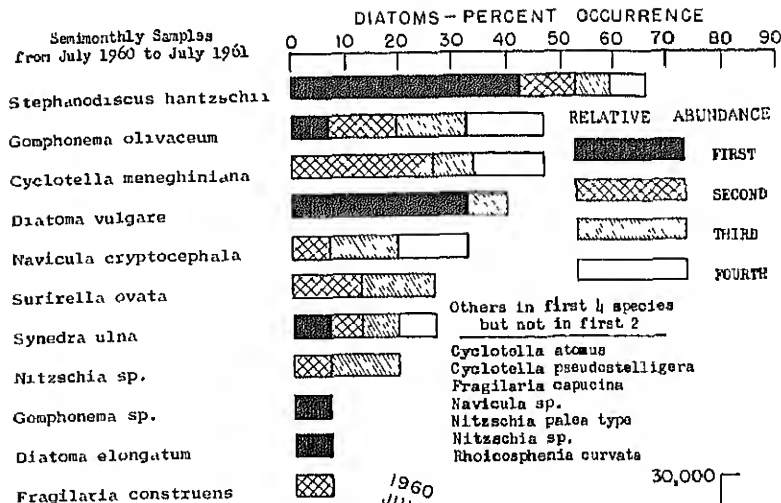
Percent frequency of counts
150 per ml. or more
From Nov. 1960 to August 1961

Blue-green algae	
Anacystis	16
Phormidium	5
Green algae	
Dictyosphaerium	11
Scenedesmus	11
Green flagellates	
Chlamydomonas	5
Trachelomonas	27
Other pigmented flagellates	
Chromulina	11
Diatoms	
Centric	
Cyclotella	11
Melosira	5
Stephanodiscus	100
Pennate	
Asterionella	5
Cymbella	5
Diatoma	6
Fragilaria	61
Navicula	15
Nitzschia	27
Surirella	5
Synedra	16



LITTLE MIAMI RIVER CINCINNATI, OHIO

Semimonthly Samples
from July 1960 to July 1961



DIATOMS - SPECIES DIVERSITY

FIRST 4 MOST ABUNDANT

ALL OTHER SPECIES

NO ANALYSIS MADE

ZOOPLANKTON

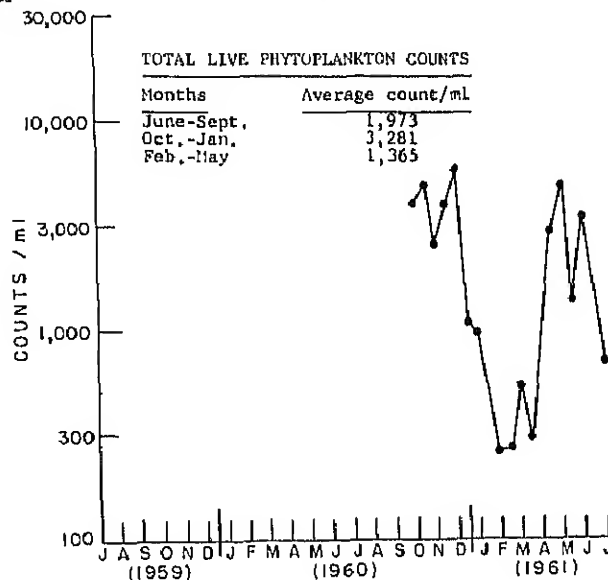
Samples analyzed 20
July 1960 to July 1961

Samples with Animals	Average count per liter per sample
Rotifers: 12	85.2
Keratella 4	4.0
Polyarthra 1	0.1
Brachionus 3	59.5
Synchaeta 4	1.4
Others 9	20.2
Crustacea: 2	0.7
Nauplii 0	0
Copepods 0	0
Cladocera 0	0
Nematodes 1	1
Other invertebrate metazoans 0	0

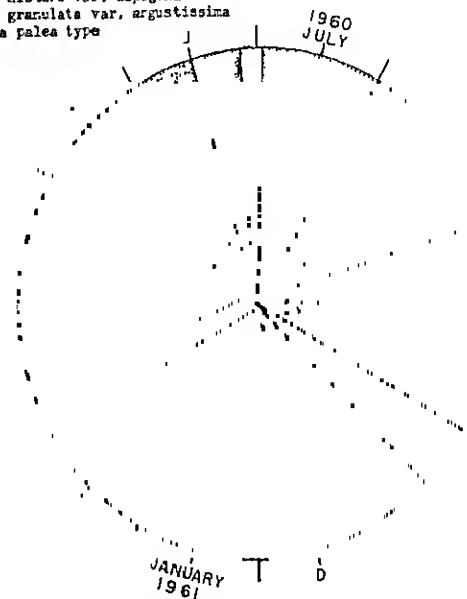
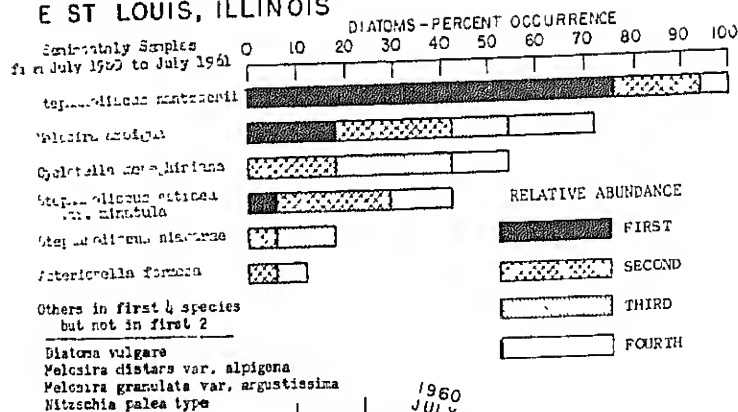
MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
October 1960 to September 1961

Green algae	
Lagerheimia	5
Oocystis	5
Green flagellates	
Chlamydomonas	20
Phacotus	5
Trachelomonas	15
Other pigmented flagellates	
Chrysococcus	5
Diatoms	
Centric	
Cyclotella	35
Molokira	5
Stephanodiscus	45
Pennate	
Diatoma	10
Navicula	20
Nitzschia	20
Surirella	5
Synedra	15



MISSISSIPPI RIVER E ST LOUIS, ILLINOIS



DIATOMS - SPECIES DIVERSITY

FIRST 4 MOST ABUNDANT

ALL OTHER SPECIES

NO ANALYSIS MADE

ZOOPLANKTON

Samples analyzed 19
July 1960 to July 1961

Samples with Animals	Average count per liter per sample
Rotifers	15
Keratella	11
Polyarthra	6
Brachionus	9
Synchaeta	5
Other genera	11
Crustaceans:	
nauplii	4
copepods	5
cladocerans	2
Nematodes	3.0
Other invertebrate metazoans	0

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
1% per ml. or more
From May 1959 to May 1961

Blue-green algae
Anacyclops

Green algae
Actinotrium
Ankistrodesmus
Scenedesmus

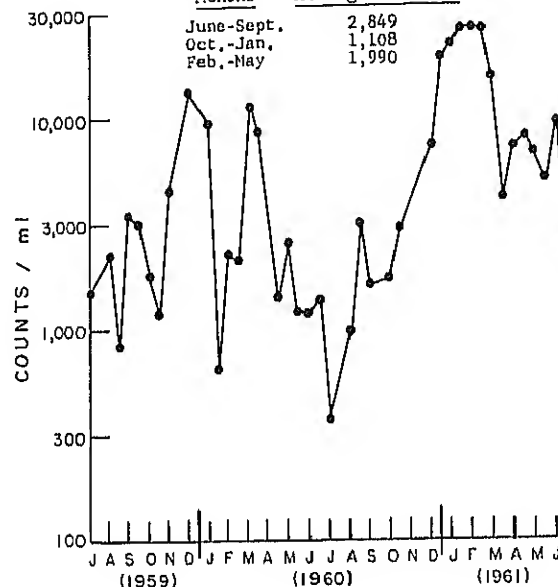
Green flagellates
Chlamydomonas
Tachydictyon

Diatoms
Centric
Pseudo-nitzschia
Cyclotella
Melosira
Stephanodiscus

Pennate
Antennella
Gyrodinium
Navicula
Nitzschia
Scribnerella
Synedra

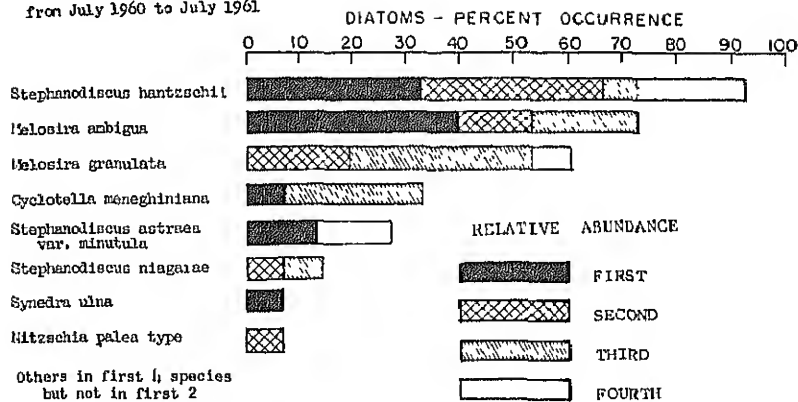
TOTAL LIVE PHYTOPLANKTON COUNTS

Months	Average count/ml.
June-Sept.	2,849
Oct.-Jan.	1,108
Feb.-May	1,990



MISSISSIPPI RIVER BURLINGTON, IOWA

Semi-monthly Samples
from July 1960 to July 1961



ZOOPLANKTON

Samples analyzed 18
July 1960 to July 1961

Samples with Animals	Average count per liter per sample
Rotifers:	14
Keratella	13
Polyarthra	10
Brachionus	9
Synchaeta	5
Other genera	9
Crustaceans, nauplii	4
copepods	5
cladocerans	2
Nematodes	2
Other invertebrate metazoans	0

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Blue-green algae

Anacystis	16
Oscillatoria	3

Green algae

Actinastrum	3
Ankistrodesmus	5
Chlorella-type	5
Microactinium	3
Oocystis	3
Scenedesmus	16
Stichococcus	3

Green flagellate algae

Chlamydomonas	21
Phacus	3
Trachelomonas	5

Other pigmented flagellates

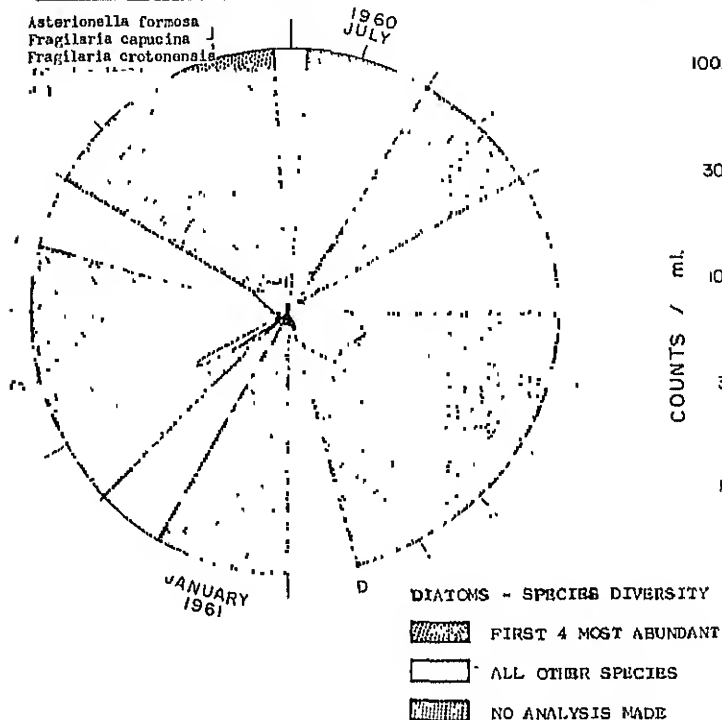
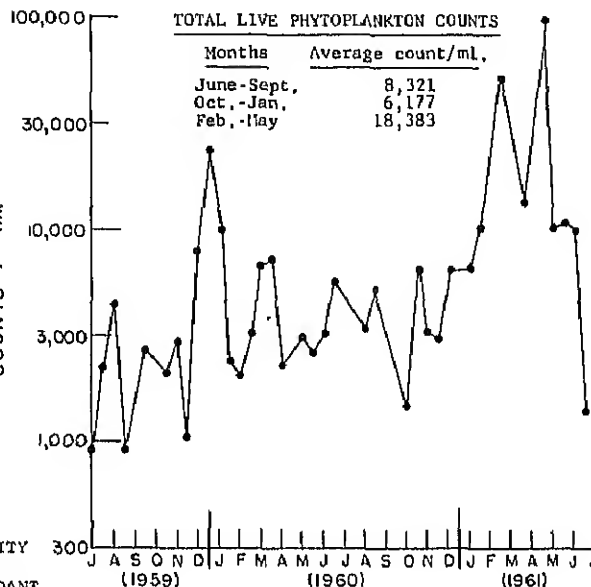
Chromulina	3
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Diatoms

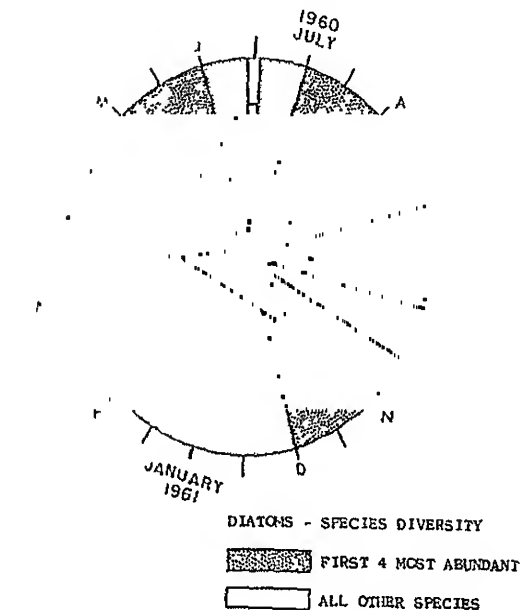
Centric	
Cyclotella	29
Melosira	66
Stephanodiscus	100

Pennate

Asterionella	11
Cymatopleura	3
Diatoms	3
Fragilaria	5
Gyrodinium	3
Navicula	8
Nitzschia	3
Surirella	5
Synedra	29



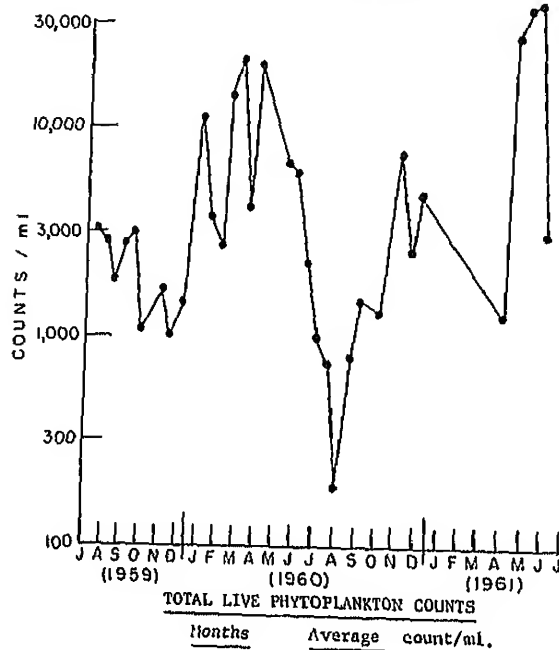
2 - July 1943
2 - July 1943



Samples analyzed 12
July 1960 to July 1961

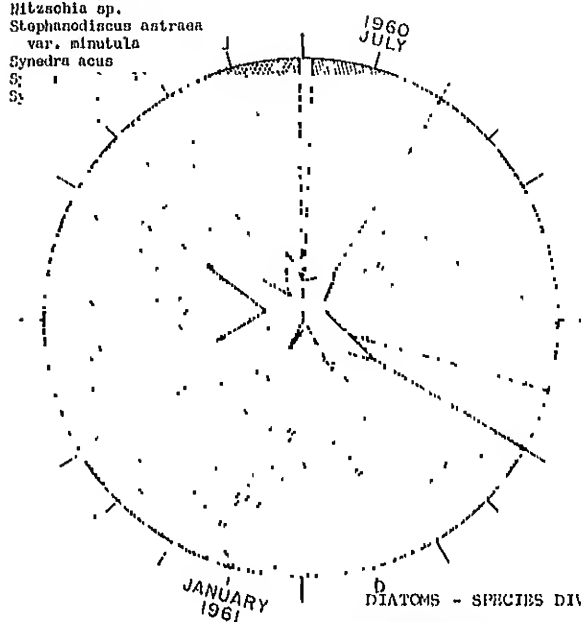
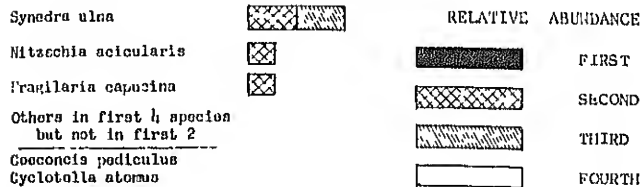
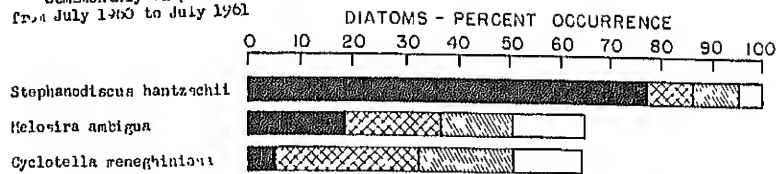
Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Blue-green algae	
Anabaena	5
Anacystis	13
Aphanizomenon	8
Green algae	
Chlorella-type	
Scenedesmus	3
Schroderia	3
Stichococcus	3
Green flagellates	
Chlamydomonas	18
Trachelomonas	3
Other pigmented flagellates	
Chromulina	3
Diatoms	
Centric	
Cyclotella	5
Melosira	66
Stephanodiscus	87
Pennate	
Asterionella	5
Diatoma	3
Fragilaria	8
Navicula	5
Nitzschia	5



MISSISSIPPI RIVER ST. PAUL, MINNESOTA

Sedimental Samples
From July 1960 to July 1961



DIATOMS - SPECIES DIVERSITY

FIRST 4 MOST ABUNDANT

ALL OTHER SPECIES

ZOOPLANKTON

Samples analyzed 22
July 1960 to July 1961

Samples with Animals

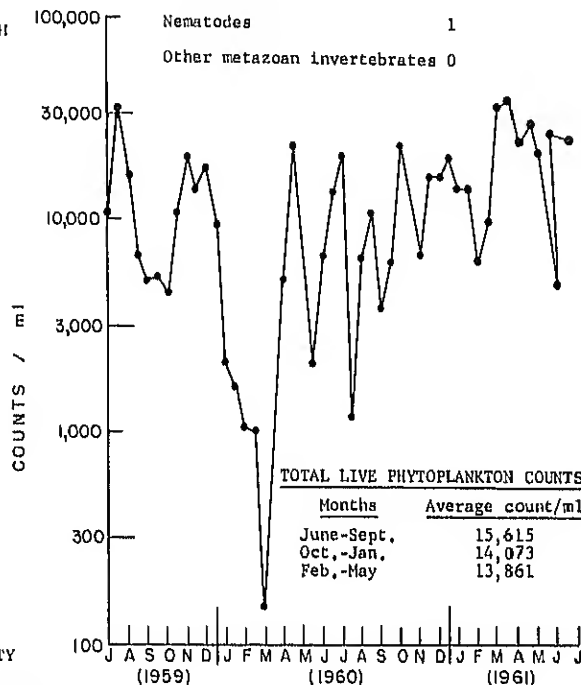
Average count per liter/sample

Rotifers:	23	242
Keratella	23	56
Polyarthra	19	28
Brachionus	5	52
Synchaeta	14	16
Other genera	20	90

Crustacea:		
nauplii	16	15
copepods	12	16
cladocerans	8	3

Nematodes 1

Other metazoan invertebrates 0



MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Blue-green algae

Aphanizomenon	14
Anaerostis	46
Aphanizomenon	7
Gomphosphaeria	2
Lyngbya	2
Oscillatoria	23
Phormidium	5

Green algae

Actinostrium	14
Ankistrodesmus	34
Chlorella-type	14
Crucigenia	5
Golenkinia	20
Microactinium	14
Oocystis	2
Palmelloccoccus	2
Scenedesmus	57
Staurastrum	2
Stichococcus	5

Green flagellates

Chlamydomonas	45
Euglena	7
Trachelomonas	23

Other pigmented flagellates

Chromulina	23
Cryptomonas	2
Dinobryon	5
Gymnodinium	5

Diatoms

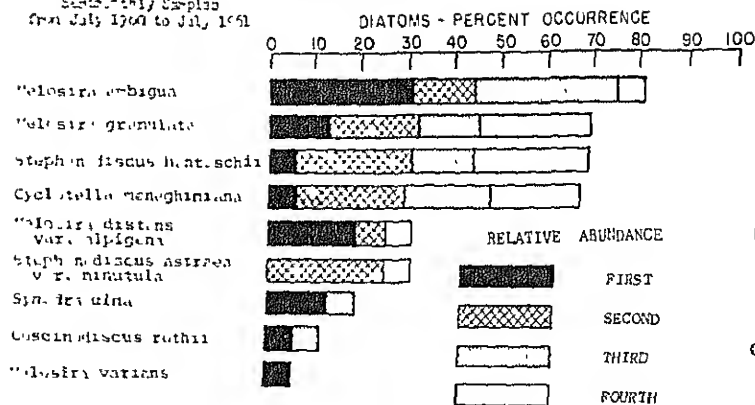
Centric	
Cyclotella	34
Melosira	45
Stephanodiscus	95

Pennate

Asterionella	9
Cocconeis	2
Cymatopleura	2
Diatoma	2
Hantzschia	18
Nitzschia	30
Synedra	43

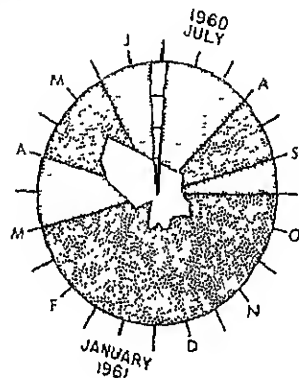
MISSISSIPPI RIVER NEW ORLEANS, LOUISIANA

Monthly Samples
from July 1960 to July 1961



Others in first 4 species
but not in first 2

Melosira granulata var. angustissima
Melosira italica
Stephanodiscus niagarae
Synedra acuta



DIATOMS - SPECIES DIVERSITY

FIRST 4 MOST ABUNDANT
ALL OTHER SPECIES
NO ANALYSIS MADE

ZOOPLANKTON

Samples analyzed 24
July 1960 to July 1961

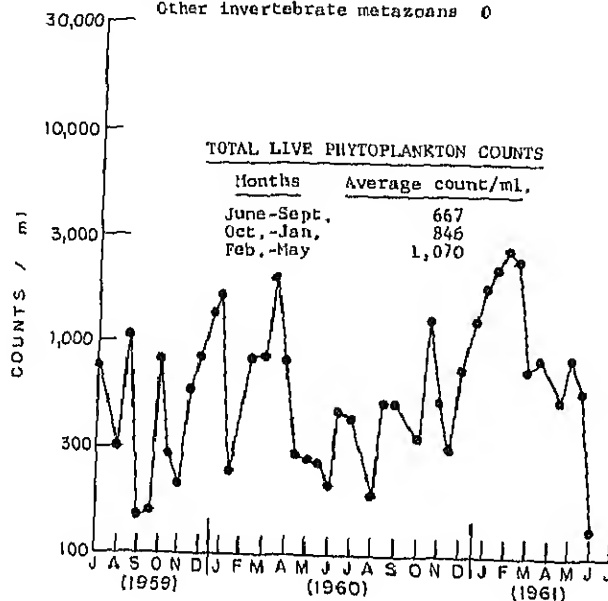
Samples with Animals	Average count per liter per sample
Rotifers, Keratella	6 0.5
Polyarthra	4 0.4
Brachionus	1 0
Synchaeta	2 0.1
Other genera	0 0
Crustaceans nauplii	3 0.1
copepods	1 0
cladocerans	1 0
Nematodes	3 0
Other invertebrate metazoans	0

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

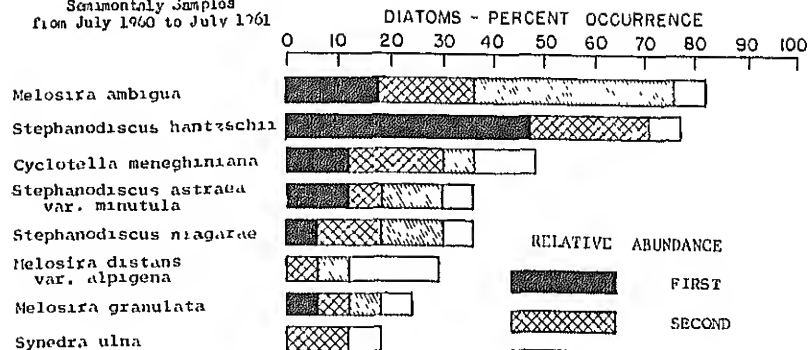
Green algae
chlorella-type 2
Scenedesmus 2

Diatoms
Centric
Cyclotella 9
Melosira 47
Stephanodiscus 51
Pennate
Synedra 4



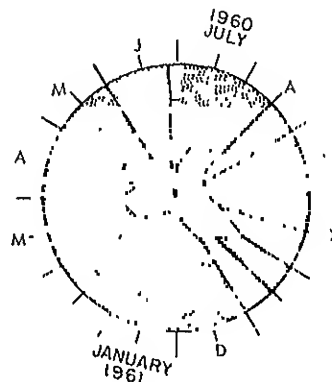
MISSISSIPPI RIVER DELTA, LOUISIANA

Seasonal Samples
from July 1960 to July 1961

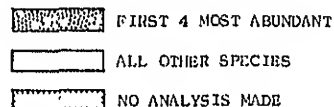


Others in first 4 species
but not in first 2

Coscinodiscus rothii
Melosira italica
Melosira varians
Hantzschia palea type
Synedra acus



DIATOMS - SPECIES DIVERSITY



ZOOPLANKTON

Samples analyzed 20
July 1960 to July 1961

Samples with Animals	Average count per liter per sample
Rotifers	6
Keratella	4
Polyarthra	1
Brachionus	2
Synchaeta	0
Other genera	2
Crustaceans.	
nauplii	2
copepods	3
cladocerans	0
Nematodes	6
Other invertebrate metazoans	0

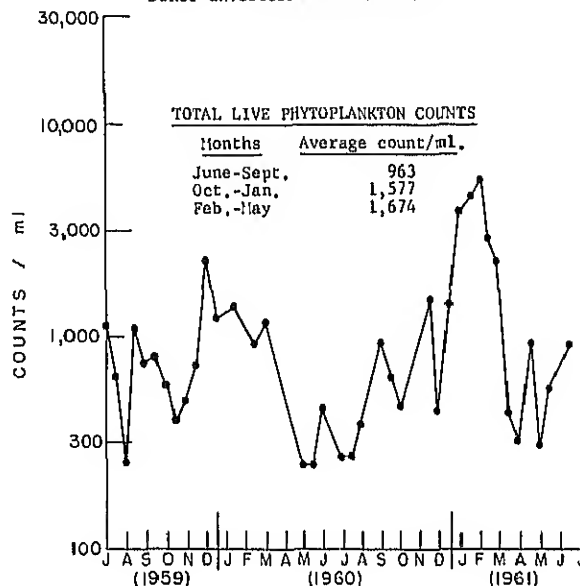
MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Green flagellates
Chlamydomonas 3

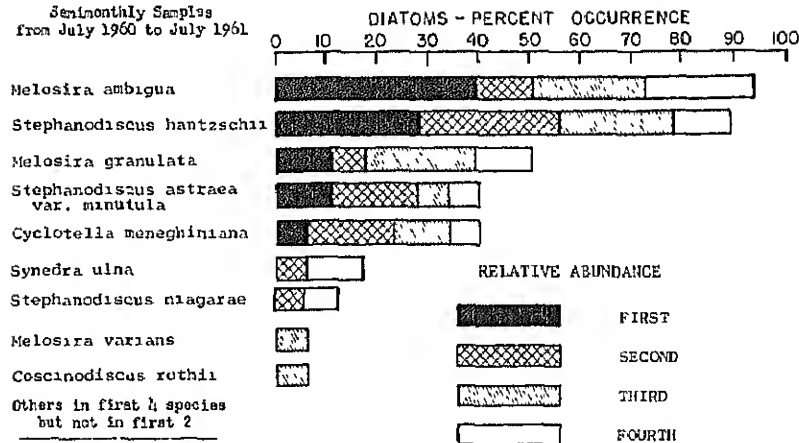
Diatoms
Centric
Cyclotella 7
Melosira 44
Stephanodiscus 67

Pennate
Fragilaria 3
Synedra 15

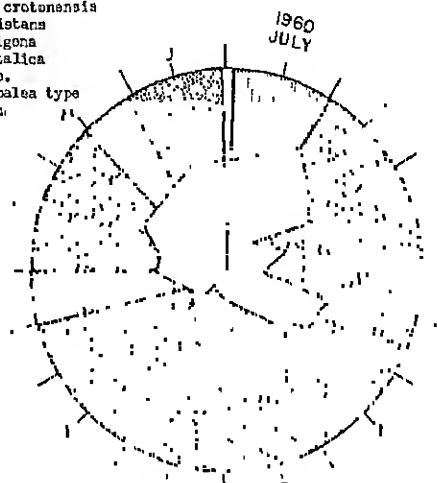


MISSISSIPPI RIVER WEST MEMPHIS, ARKANSAS

Semi-monthly Samples
from July 1960 to July 1961



Asterionella formosa
Fragilaria crotonensis
Melosira distans
var. alpigona
Melosira italica
Navicula sp.
Nitzschia palea type
Synedra acuta



DIATOMS - SPECIES DIVERSITY

FIRST 4 MOST ABUNDANT
ALL OTHER SPECIES
NO ANALYSIS MADE

ZOOPLANKTON

Samples analyzed 21
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers	8	3.7
Keratella	5	1.4
Polyarthra	6	0.5
Brachionus	5	1.5
Synchaeta	1	0
Crustaceans:		
nauplii	2	0.1
copepods	2	0.1
cladocerans	2	0.1
Nematodes		2.0
Other invertebrate metazoans		0

MOST ABUNDANT GENERA OF ALGAE

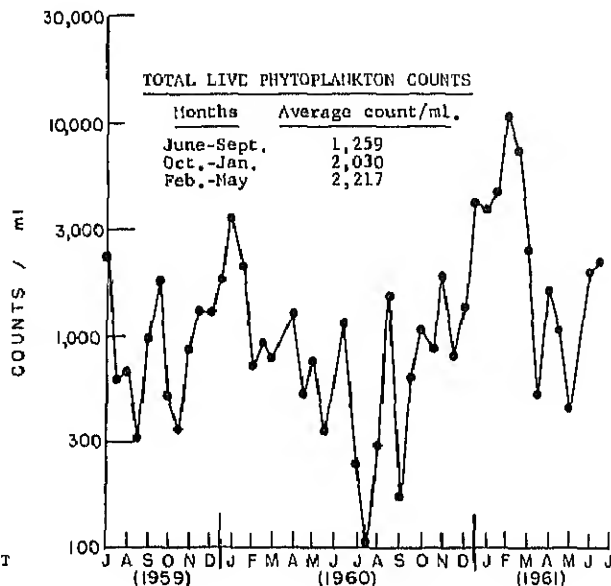
Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Green algae	
Scenedesmus	6
Green flagellates	
Chlamydomonas	2
Phacus	2
Trachelomonas	2

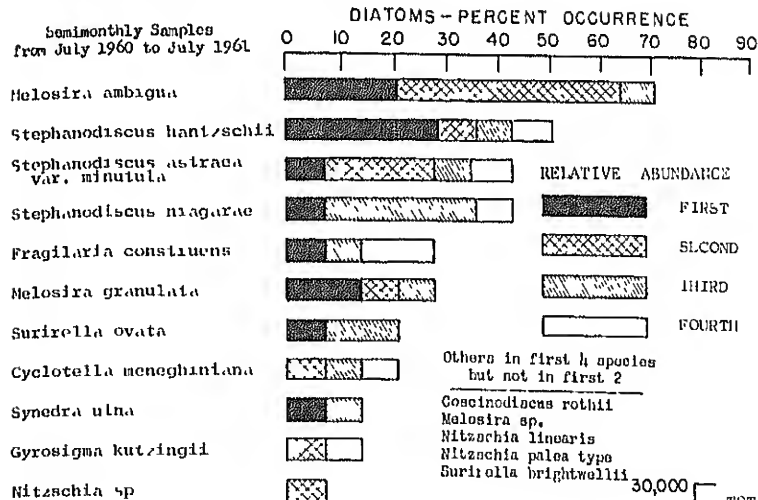
Other pigmented flagellates
Chromulina 2

Diatoms	
Centric	
Cyclotella	10
Melosira	54
Stephanodiscus	77

Pennate	
Asterionella	2
Synedra	27



MISSISSIPPI RIVER CAPE GIRARDEAU, MISSOURI



ZOOPLANKTON

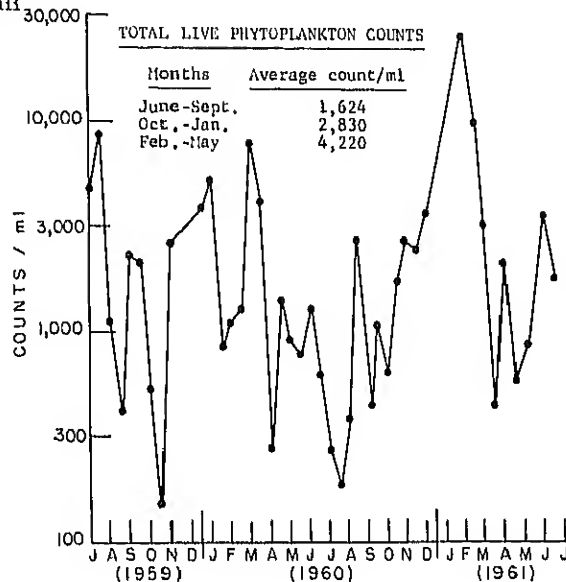
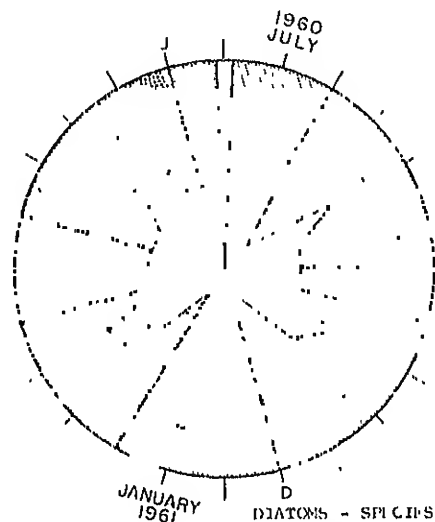
Samples analyzed 19
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers	7	2.8
Keratella	4	1.0
Polyarthra	4	0
Brachionus	6	1.2
Synchaeta	2	0
Other genera	3	0.8
Crustaceans:		
nauplii	1	0
copepods	3	0
cladocerans	0	0
Nematodes		1
Other invertebrate metazoans		0

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml or more
From May 1959 to May 1961

Green algae	
Scenedesmus	7
Tetradlesmus	2
Green flagellates	
Chlamydomonas	5
Other pigmented flagellates	
Chromulina	2
Diatoms	
Centric	
Cyclotella	20
Melosira	39
Stephanodiscus	73
Pennate	
Asterionella	5
Diatoma	2
Gyrosigma	2
Navicula	2
Nitzschia	5
Surirella	7
Synedra	20

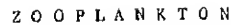
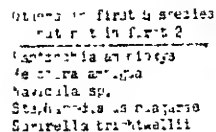


FIRST 4 MOST ABUNDANT

ALL OTHER SPECIES

NO ANALYSIS MADE

$\frac{1}{2} \left(\frac{1}{2} + \frac{1}{2} \right) = \frac{1}{2}$



Samples analyzed 23
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers.	3	0
Keratella	1	0
Polyarthra	0	0
Brachionus	0	0
Synchaeta	0	0
Other genera	1	0
Crustaceans:		
nauplii	1	0
copepods	3	0
cladocerans	0	0
Nematodes		2
Other invertebrate metazoans		0

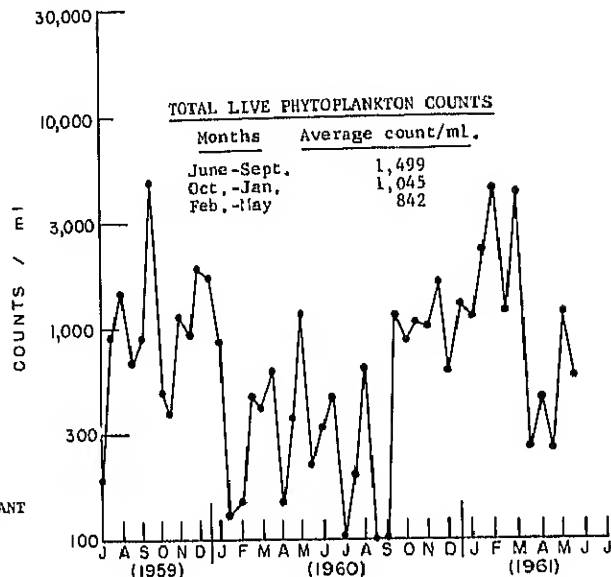
Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Green algae	
Ankistrodesmus	2
Scenedesmus	4

Green flagellates	
Chlamydomonas	4
Tracholomonas	2

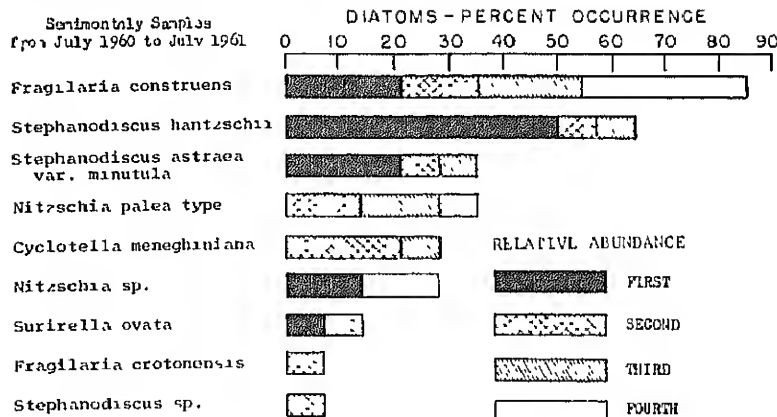
Diatoms	
Centric	
Cyclotella	6
Melosira	6
Stephanodiscus	53

Laminate	
Asterionella	4
Pragilaria	2
Gomphonema	2
Havicula	2
Synedra	23



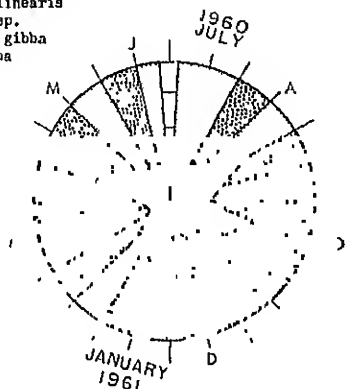
MISSOURI RIVER KANSAS CITY, KANSAS

Semimonthly Samples
from July 1960 to July 1961

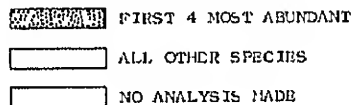


Others in first 4 species
but not in first 2

Amphiprora paludosa
Fragilaria capucina
Nitzschia acicularis
Nitzschia linearis
Nitzschia sp.
Rhopalodia gibba
Synedra ulna



DIATOMS - SPECIES DIVERSITY



ZOOPLANKTON

Samples analyzed 18
July 1960 to July 1961

Samples with Animals Average count per liter per sample

Rotifers 0
Keratella 0
Polyarthra 0
Brachionus 0
Synchaeta 0
Others 0

Crustacea:
nauplii 0
Copepods 0
Cladocera 0
Nematodes 0
Other invertebrate metazoan 0

MOST ABUNDANT GENERA OF ALGAE

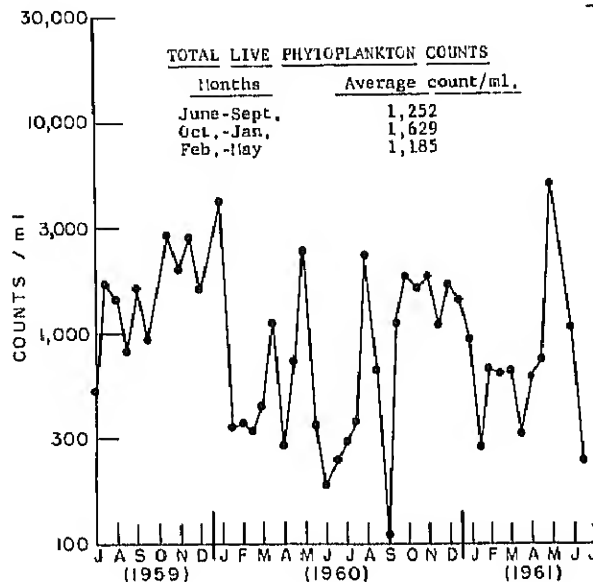
Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Green algae
Ankistrodesmus 2
Scenedesmus 13

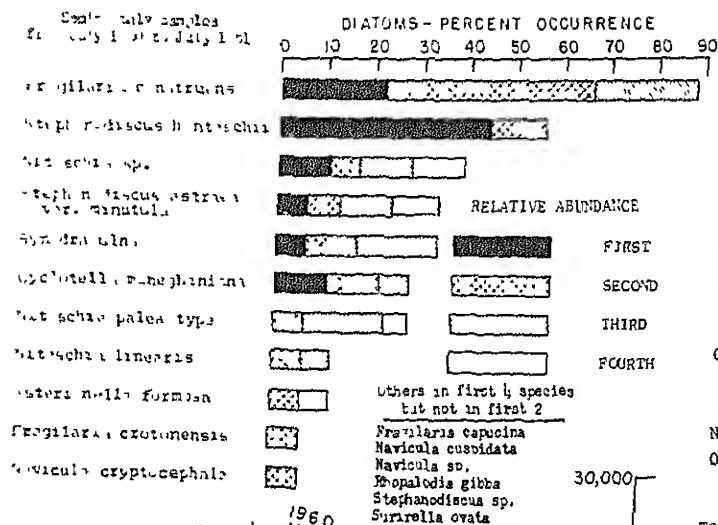
Green Flagellates
Chlamydomonas 17
Phacotus 2
Trachelomonas 2

Diatoms
Centric
Cyclotella 13
Melosira 9
Stephanodiscus 57

Pennate
Asterionella 6
Fragilaria 11
Gomphonema 2
Navicula 6
Nitzschia 11
Surirella 4
Synedra 21



MISSOURI RIVER ST JOSEPH, MISSOURI



ZOOPLANKTON

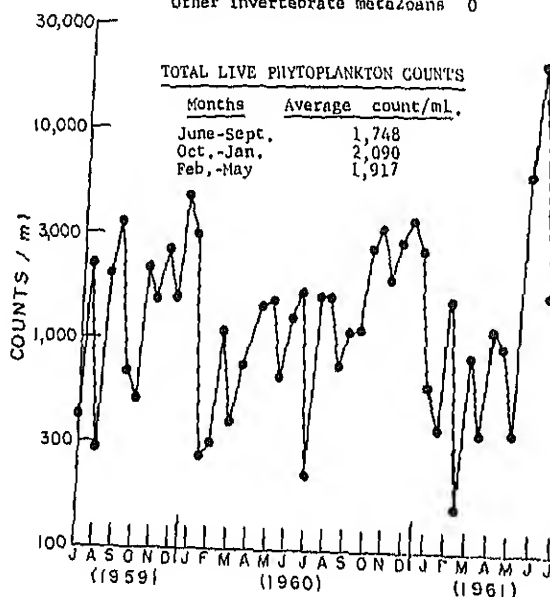
Samples analyzed 21
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers:	1	0.1
Keratella	0	0
Polyarthra	0	0
Brachionus	1	0
Synchaeta	0	0
Other genera	0	0
Crustaceans:		
nauplii	0	0
copepods	2	0.6
cladocerans	0	0
Nematodes		3
Other invertebrate metazoans		0

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
from May 1959 to May 1961

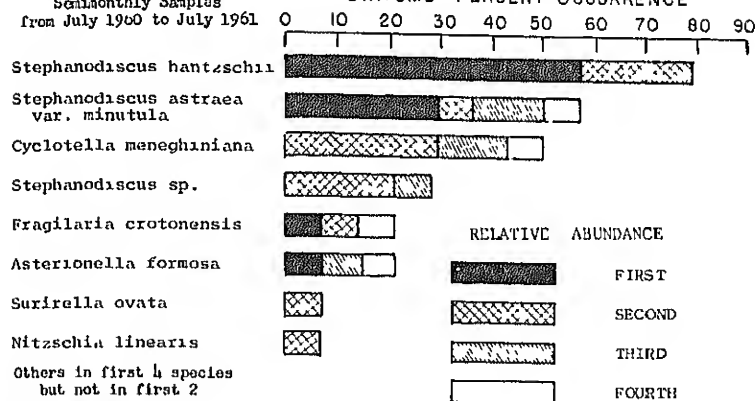
Blue-green algae	
Anacystis	2
Green algae	
Actinastrium	2
Ankistrodesmus	6
Scenedesmus	14
Green flagellates	
Chlamydomonas	16
Euglena	2
Trachomonas	10
Diatoms	
Centric	
Cyclotella	18
Melosira	16
Stephanodiscus	22
Pennate	
Asterionella	14
Flagellaria	16
Navicula	4
Nitzschia	16
Synedra	22



MISSOURI RIVER OMAHA, NEBRASKA

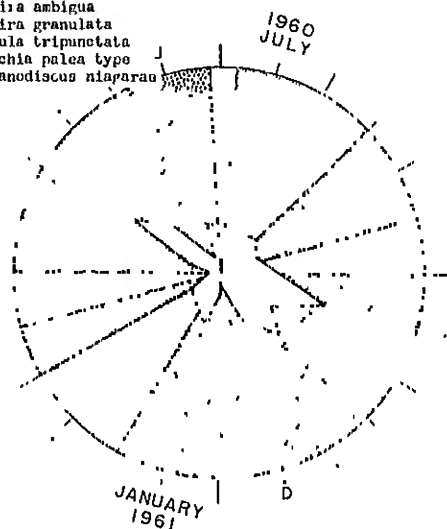
Semi-monthly Samples
from July 1960 to July 1961

DIATOMS - PERCENT OCCURRENCE

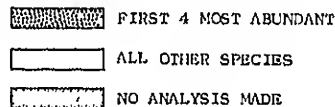


Others in first 4 species
but not in first 2

Cymbella lunata
Diatoma vulgare
Melosira ambigua
Melosira granulata
Navicula tripunctata
Nitzschia palea type
Stephanodiscus niagarae



DIATOMS - SPECIES DIVERSITY



ZOOPLANKTON

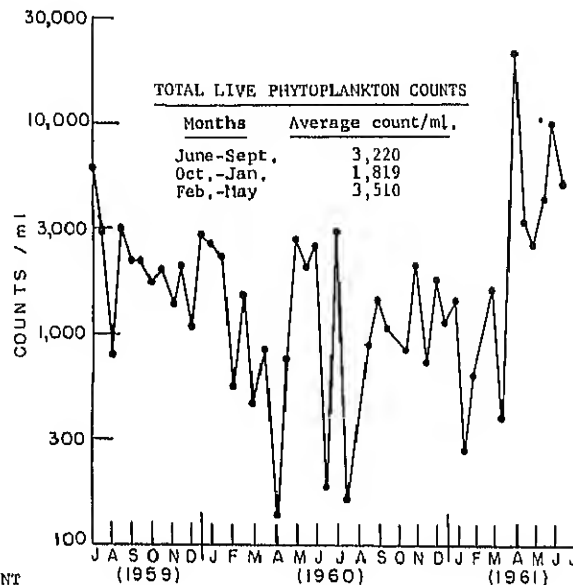
Samples analyzed 20
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers:	3	0.5
Keratella	1	0.1
Polyarthra	1	0.1
Brachionus	2	0.3
Synchaeta	0	0
Other genera	0	0
Crustaceans:		
nauplii	2	0.3
copepods	5	0.5
cladocerans	1	0.1
Nematodes	3	
Other invertebrate metazoans	0	

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Green algae	
Ankistrodesmus	7
Chlorella-type	2
Oocystis	2
Scenedesmus	11
Selenastrum	2
Stichococcus	2
Green flagellates	
Chlamydomonas	24
Trachelomonas	7
Other pigmented flagellates	
Chrysococcus	2
Diatoms	
Centric	
Cyclotella	7
Melosira	17
Stephanodiscus	65
Pennate	
Asterionella	22
Diatoma	2
Navicula	2
Nitzschia	17
Surirella	7
Synedra	22

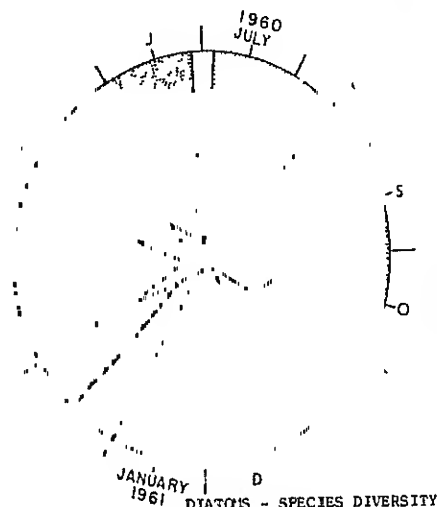
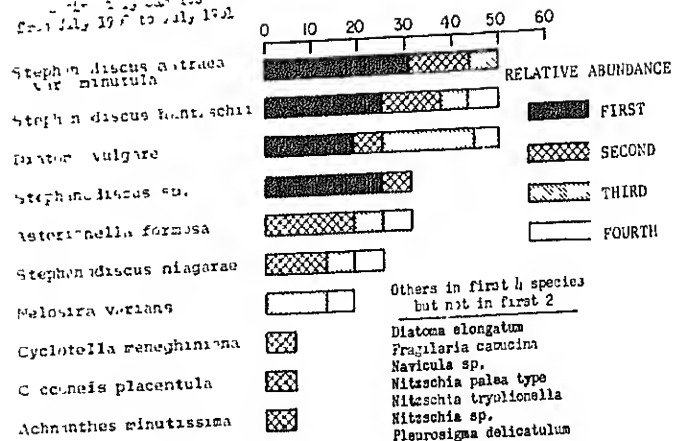


TOTAL LIVE PHYTOPLANKTON COUNTS

Months	Average count/ml.
June-Sept.	3,220
Oct.-Jan.	1,819
Feb.-May	3,510

MISSOURI RIVER YANKTON, SOUTH DAKOTA

July 1959 to July 1961



FIRST 4 MOST ABUNDANT
ALL OTHER SPECIES

ZOOPLANKTON

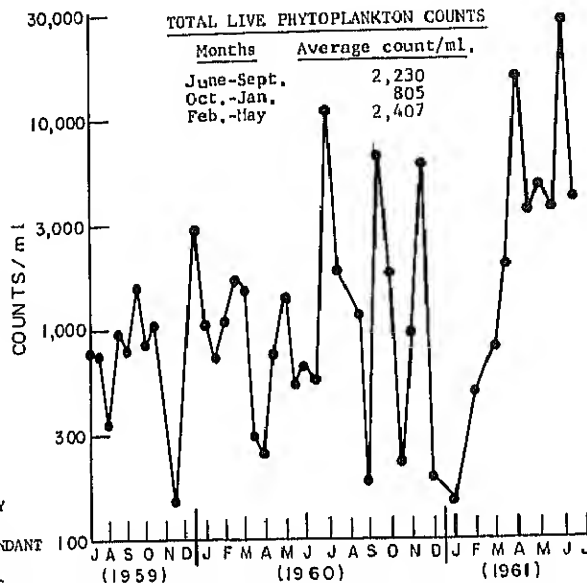
Samples analyzed 74
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers.	16	27.3
Keratella	8	20.9
Polyarthra	6	1.5
Brachionus	4	0.6
Synchaeta	6	2.0
Other genera	11	2.3
Crustaceans.		
nauplii	10	3.9
copepods	10	6.5
cladocerans	3	2.0
Nematodes		0
Other invertebrate metazoans		0

MOST ABUNDANT GENERA OF ALGAE

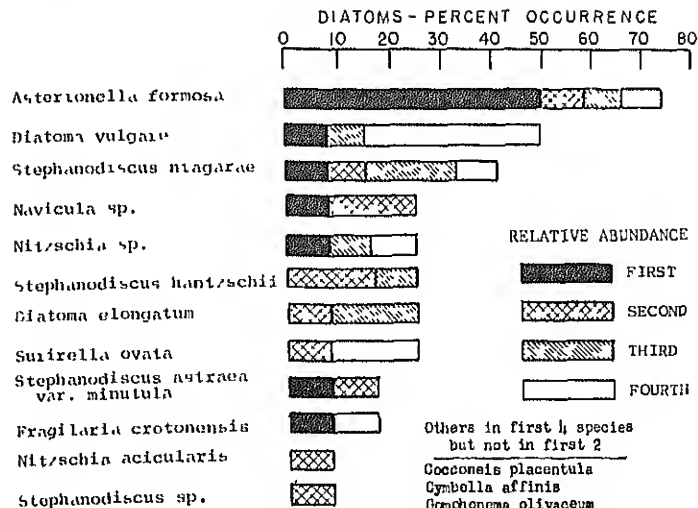
Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Blue-green algae	
Anacystis	2
Green algae	
Ankistrodesmus	7
Chlorella-type	4
Scenedesmus	4
Selenastrum	1
Green flagellates	
Chlamydomonas	11
Euglena	2
Trachelomonas	13
Other pigmented flagellates	
Gymnodinium	2
Diatoms	
Centric	
Cyclotella	4
Melosira	2
Stephanodiscus	72
Pennate	
Asterionella	26
Cocconeis	2
Cymbella	4
Diatoma	11
Gomphonema	2
Navicula	4
Nitzschia	9
Pleurosigma	2
Synedra	9



MISSOURI RIVER BISMARCK, NORTH DAKOTA

Seasonally Samples
From July 1960 to July 1961



RELATIVE ABUNDANCE

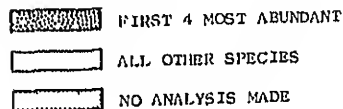
FIRST
SECOND
THIRD
FOURTH

Others in first 4 species but not in first 2

Gocconeis placentula
Cymbella affinis
Gomphonema olivaceum
Melosira ambigua
Nitzschia palea type
Nitzschia sp.



DIATOMS - SPECIES DIVERSITY



MOST ABUNDANT GENERA OF ALGAE

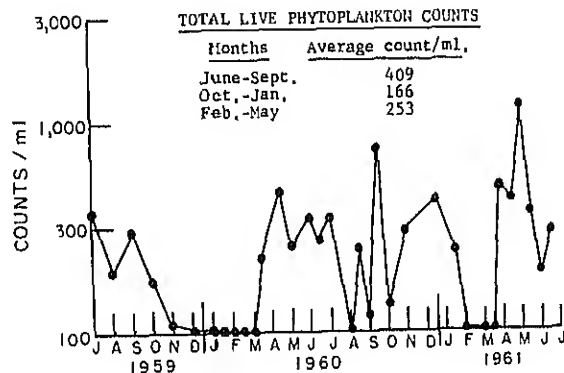
Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Diatoms	
Centric	
Stephanodiscus	9
Pennate	
Asterionella	3
Synedra	0

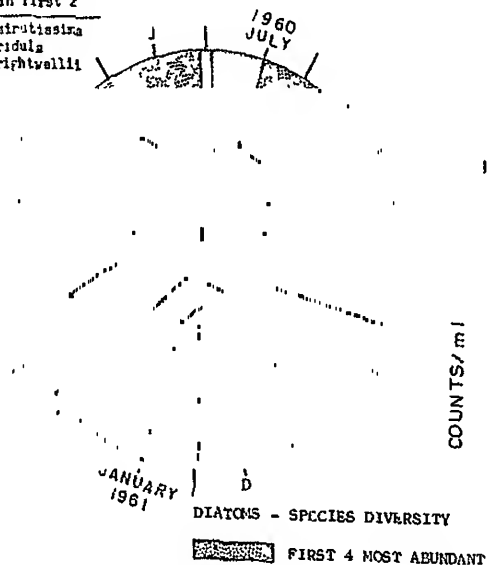
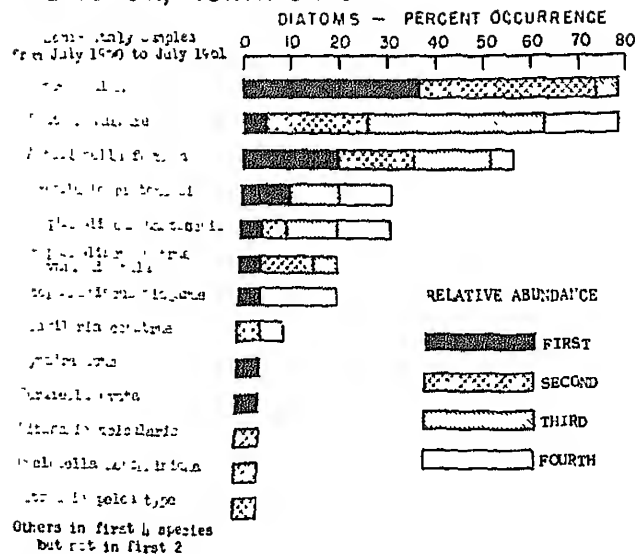
ZOOPLANKTON

Samples analyzed 19
July 1960 to July 1961

Samples with Animals	Average count per liter per sample
Rotifers	8
Keratella	3
Polyarthra	5
Brachionus	1
Synchaeta	0
Crustaceans, nauplii	9
copepods	6
cladocerans	1
Nematodes	2.0
Other invertebrate metazoans	0



MISSOURI RIVER WILLISTON, NORTH DAKOTA



ZOOPLANKTON

Samples analyzed 24
July 1960 to July 1961

Samples with Animals	Average count per liter per sample
Rotifers.	8
Keratella	1
Polyarthra	1
Brachionus	1
Synchaeta	1
Other genera	3
Crustaceans.	
nauplii	1
copepods	3
cladocerans	0
Nematodes	1
Other metazoan invertebrates	none

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Blue-green algae
Anacystis 6
Aphanizomenon 3

Green algae
Actinastrum 3
Ankistrodesmus 3
Coccytis 3
Scenedesmus 6

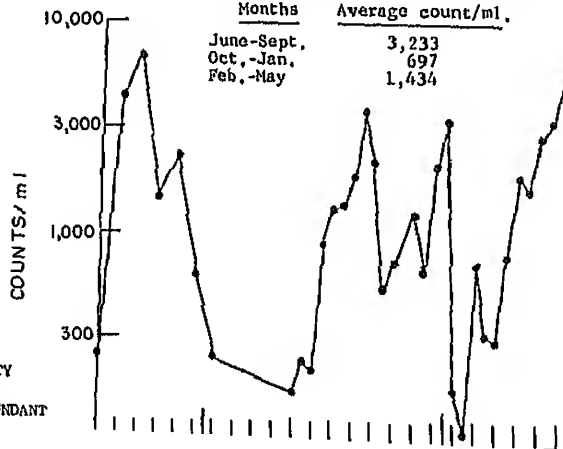
Green flagellates
Chlamydomonas 6
Trachelomonas 6

Diatoms
Centric
Cyclotella 8
Stephanodiscus 47

Fennate
Asterionella 36
Cymbella 6
Diatoms 22
Fragilaria 17
Navicula 25
Hitzschia 25
Surirella 3
Synedra 44

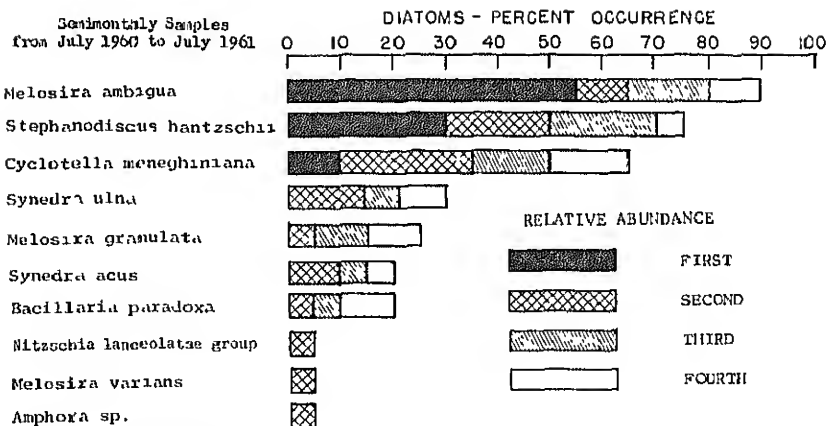
TOTAL LIVE PHYTOPLANKTON COUNTS

Months	Average count/ml.
June-Sept.	3,233
Oct.-Jan.	697
Feb.-May	1,434



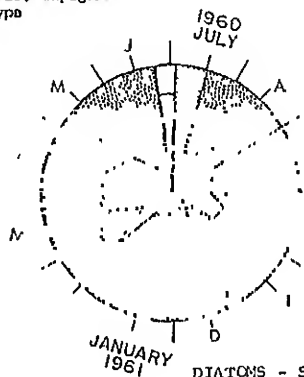
OHIO RIVER
CAIRO, ILLINOIS

Sanimonthly Samples
from July 1960 to July 1961



Others in first 4 species
but not in first 2

Cyclotella atomus
Cymbella affinis
Fragilaria crotonensis
Melosira distans var. alpigena
Nitzschia palea type
Surirella ovata



DIATOMS - SPECIES DIVERSITY

FIRST 4 MOST ABUNDANT

ALL OTHER SPECIES
1

NO ANALYSIS MADE

Z O O P L A N K T O N

Samples analyzed 24
July 1960 to July 1961

	<u>Samples with Animals</u>	<u>Average count per liter per sample</u>
Rotifers	9	3.0
Keratella	6	2.0
Polyarthra	1	0
Brachionus	5	1.0
Synchaeta	1	0
Other genera	3	0
Crustaceans:		
nauplii	0	0
copepods	1	0.1
cladocerans	8	0.6
Nematodes		2.0
Other invertebrate metazoans		0

M O S T A B U N D A N T
G E N E R A O F A L G A E

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Blue-green algae
Anacystis 0

Green algae	
Ankistrodemon	4
chlorella-type	2
Scenedesmus	4
Stichococcus	2

Green flagellates	
Chlamydomonas	2
Trachelomonas	2
Other pigmented flagellates	
Chromulina	2

Diatoms	
Centric	
Cyclotella	38
Melosira	40
Stephanodiscus	22

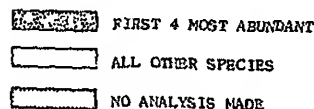
Pennate	
Gomphonema	4
Nitzschia	2
Synedra	32

TOTAL LIVE PHYTOPLANKTON COUNTS

Months	Average count/ml.
June-Sept.	757
Oct.-Jan.	1,975
Feb.-May	1,501

Graph showing monthly counts of *E. coli* in the Hudson River from July 1959 to July 1961. The Y-axis is logarithmic, labeled "COUNTS / ml", with major ticks at 100, 300, 1,000, 3,000, and 10,000. The X-axis shows months from July 1959 to July 1961. A table in the upper right corner provides average counts for specific periods: June-Sept. (757), Oct.-Jan. (1,975), and Feb.-May (1,501). The graph shows significant seasonal fluctuations, with peaks often occurring in late summer or early fall.

randomly samples
from Jul, 1970 to July 1971



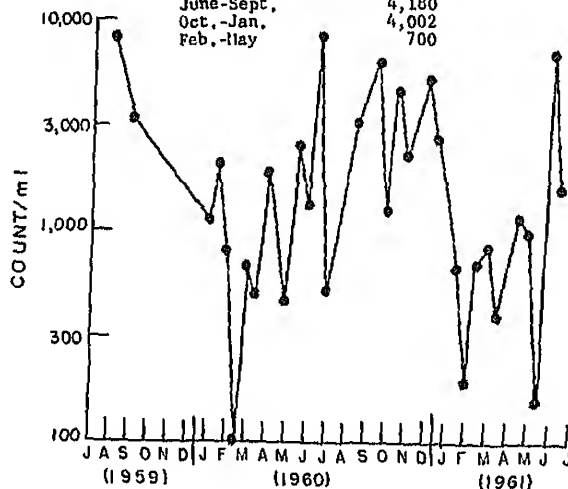
Samples analyzed 21
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers	14	71
Keratella	12	59
Polyarthra	11	4
Brachionus	6	2
Synchaeta	2	0
Others	10	6
Crustacea:		
Hauplii	5	1.7
Copepods	7	1.7
Cladocera	6	1.4
Nematodes		5
Other invertebrate metazoans		0

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

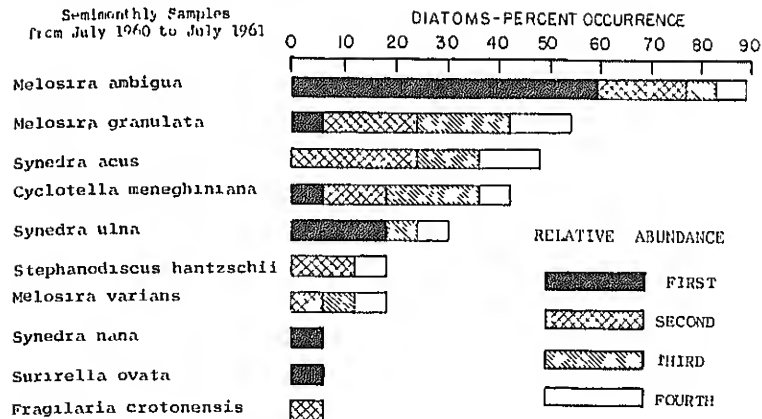
Blue-green algae	
Anabaena	3
Anacystis	15
Aphanizomenon	4
Oscillatoria	6
Green algae	
Actinastrum	3
Ankistrodemon	4
Dictyosphaerium	3
Golenkinia	3
Micractinium	3
Oocystis	3
Radococcus	3
Scenedesmus	15
Spirogyra	3
Tetrademon	3
Tetrasira	3
Ulothrix	4
Wetzelia	3
Green flagellates	
Chlamydomonas	9
Trachelomonas	3
Other pigmented flagellates	
Chromulina	9
Diatoms	
Centric	
Cyclotella	3
Melosira	70
Stephanodiscus	36
Pennate	
Asterionella	9
Gomphonema	3
Navicula	3
Suriella	3
Synedra	48

Months	Average count/ml
June-Sept.	4,180
Oct. -Jan.	4,002
Feb. -May	700



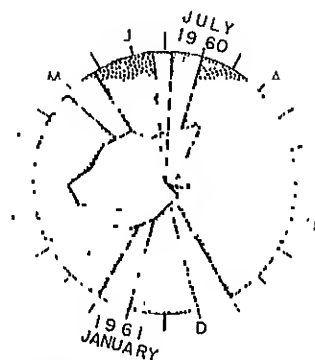
OHIO RIVER CINCINNATI, OHIO

Semi-monthly Samples
from July 1960 to July 1961



Others in first 4 species
but not in first 2

Gomphonema parvulum
Gyrosigma kutzingii
Melosira distans var. alpicornis
Nitzschia palea type
Pinnularia sp.



ZOOPLANKTON

Samples analyzed 21
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers.	12	58.0
Keratella	10	39.7
Polyarthra	10	5.6
Brachionus	9	6.6
Synchaeta	4	3.5
Other genera	8	11.1
Crustaceans		
nauplii	6	1.3
copepods	6	2.0
cladocerans	7	2.0
Nematodes		2.0
Other invertebrate metazoans		0

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Blue-green algae

Arabaena	9
Anacyclops	27
Aphanizomenon	9
Arthrospira	2
Coccolithus	18
Phormidium	4
Raphidiopsis	2

Green algae

Actinastrum	4
Ankistrodesmus	13
Chlorococcoides-type	20
Chlorococcum	7
Diatyosphaerium	10
Dimorphococcus	2
Colaninia	7
Oocystis	4
Palaeococcus	2
Scenedesmus	27

Green flagellates

Chlamydomonas	20
Trachelomonas	11

Other pigmented flagellates (Chroococcoides)

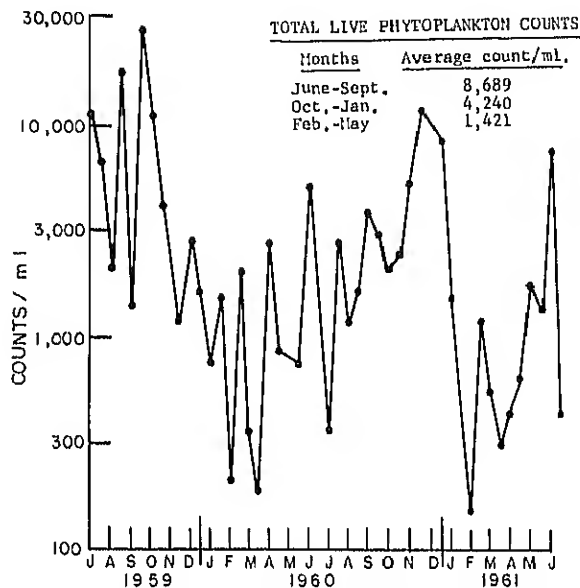
Chroococcoides	11
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Diatoms

Centric	
Cyclotella	42
Melosira	62
Stephanodiscus	18

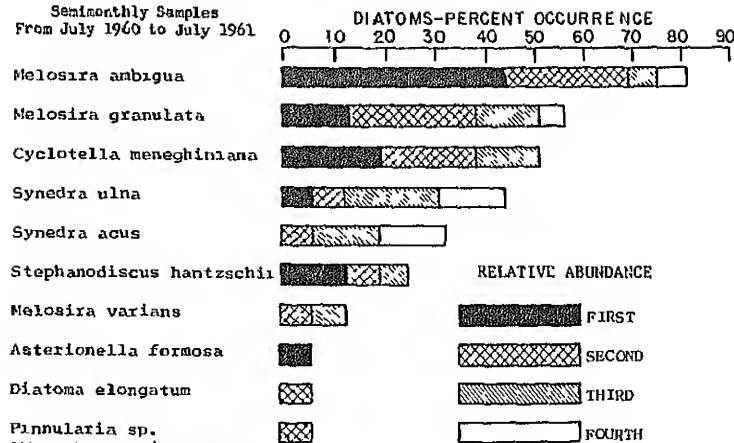
Pennate

Asterionella	7
Cymbella	4
Diadema	2
Gomphonema	7
Navicula	16
Nitzschia	11
Pinnularia	69



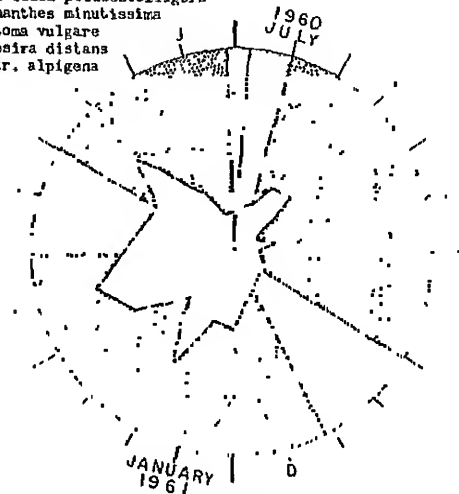
OHIO RIVER HUNTINGTON, WEST VIRGINIA

Semimonthly Samples
From July 1960 to July 1961



Others in first 4 species
but not in first 2

Cyclotella pseudostelligera
Achnanthes minutissima
Diatoma vulgare
Melosira distans
var. alpigena



DIATOMS - SPECIES DIVERSITY

FIRST 4 MOST ABUNDANT
ALL OTHER SPECIES

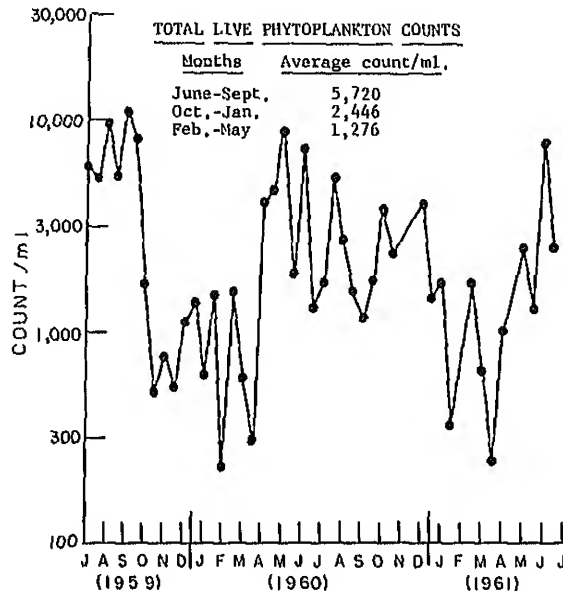
ZOOPLANKTON

Samples analyzed 21
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers:	13	28
Keratella	12	20
Polyarthra	10	6
Brachionus	9	2
Synchaeta	7	1
Other genera	8	0
Crustaceans:		
nauplii	6	1.1
copepods	5	2.0
cladocerans	6	1.3
Nematodes		0
Other invertebrate metazoans		0

TOTAL LIVE PHYTOPLANKTON COUNTS

Months	Average count/ml.
June-Sept.	5,720
Oct.-Jan.	2,446
Feb.-May	1,276



MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Blue-green algae

Anabaena 7

Anacystis 24

Gomphosphaeria 4

Oscillatoria 7

Rhaphidiopsis 2

Green algae

Actinastrum 4

Ankistrodesmus 24

Chlorella-type 9

Coelastrum 2

Dictyosphaerium 4

Golenkinia 9

Kirchneriella 2

Lagerheimia 2

Microactinium 2

Oocystis 4

Scenedesmus 36

Selenastrium 2

Staurastrum 2

Tetradasmus 7

Green flagellates

Chlamydomonas 20

Phacotus 2

Trachelomonas 4

Other pigmented flagellates

Chromulina 7

Chrysococcus 2

Diatoms

Centric

Cyclotella 47

Melosira 64

Stephanodiscus 20

Pennate

Asterionella 9

Diatoma 4

Fragilaria 2

Gomphonema 2

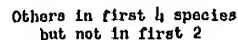
Navicula 11

Nitzschia 11

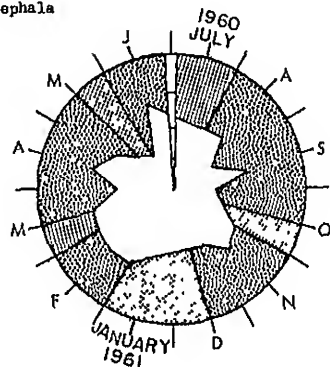
Suriella 2




Synedra 60

Semimonthly Samples
from July 1960 to July 1961



Achnanthes minutissima
Cocconeia placentula
Diatoma elongatum
Diatoma vulgare
Fragilaria capucina
Frustulia vulgaris
Navicula cryptocephala
Navicula sp.
Nitzschia sp.
Nitzschia sp.



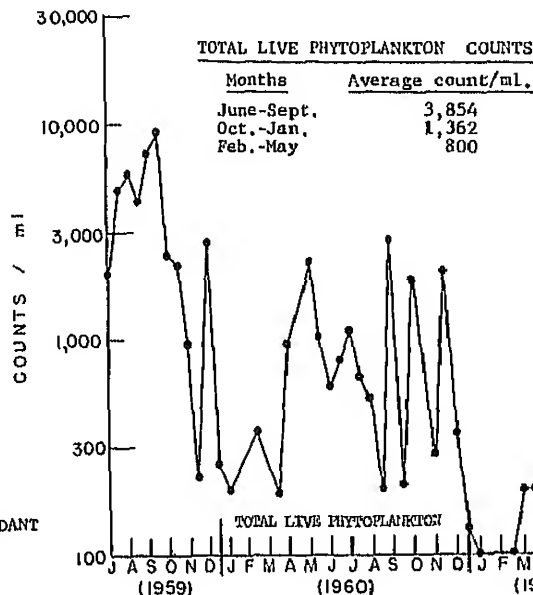
 FIRST 4 MOST ABUNDANT
 ALL OTHER SPECIES
 NO ANALYSIS MADE

Samples analyzed 20
July 1960 to July 1961

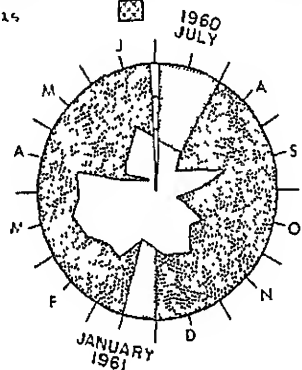
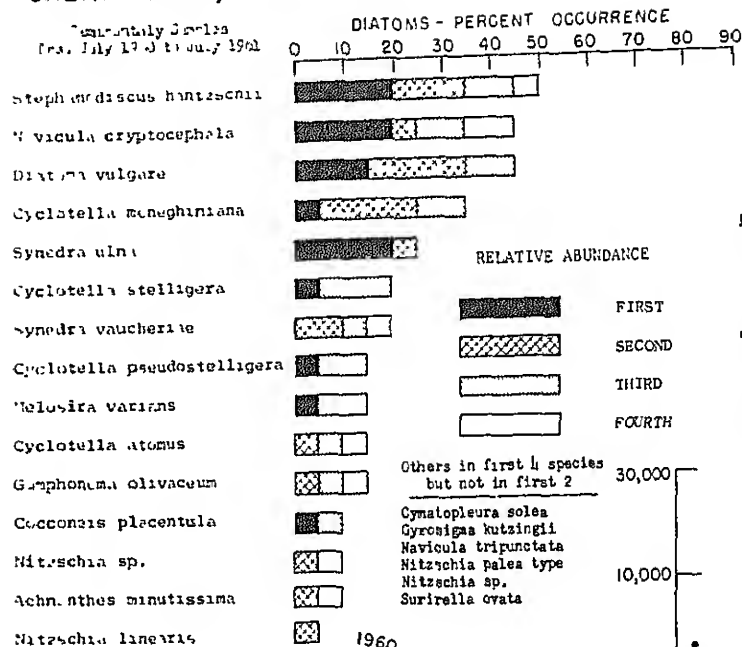
	<u>Samples with Animals</u>	<u>Average count per liter per sample</u>
Rotifers:	10	13.0
Keratella	5	1.0
Polyarthra	4	1.0
Brachionus	7	3.4
Synchaeta	2	3.0
Other genera	7	4.6
Crustaceans.		
nauplii	6	1.7
copepods	4	4.0
cladocerans	1	1.0
Nematodes		1.0
Other invertebrate metazoans		0

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

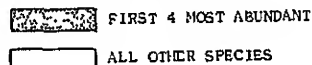
Blue-green algae	
Anacyctis	13
Calothrix	2
Gomphosphaeria	9
Oscillatoria	2
Green algae	
Actinastrium	7
Ankistrodesmus	20
Chlorella-type	11
Closterium	4
Coelastrum	2
Dictyosphaerium	2
Golenkinia	4
Microctinium	2
Palmellococcus	2
Scenedesmus	24
Tetrademus	11
Tetraspora	2
Green flagellates	
Chlamydomonas	28
Trachalemonas	4
Other pigmented flagellates	
Chromulina	9
Diatoms	
Centric	
Cyclotella	24
Melosira	9
Stephanodiscus	9
Pennata	
Asterionella	4
Diatoma	2
Gomphonema	4
Navicula	13
Nitzschia	7
Synedra	37



POTOMAC RIVER GREAT FALLS, MARYLAND



DIATOMS - SPECIES DIVERSITY



ZOOPLANKTON

Samples analyzed 24
July 1960 to July 1961

Samples with Animals	Average count per liter per sample
Rotifers	7
Keratella	4
Polyarthra	2
Brachionus	2
Synchaeta	0
Other genera	6
Crustaceans: nauplii	0
copepods	1
cladocerans	0
Nematodes	3
Other invertebrate metazoans	0

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml or more
From May 1959 to May 1961

Blue-green algae	
Agmenellum	6
Anacystis	14

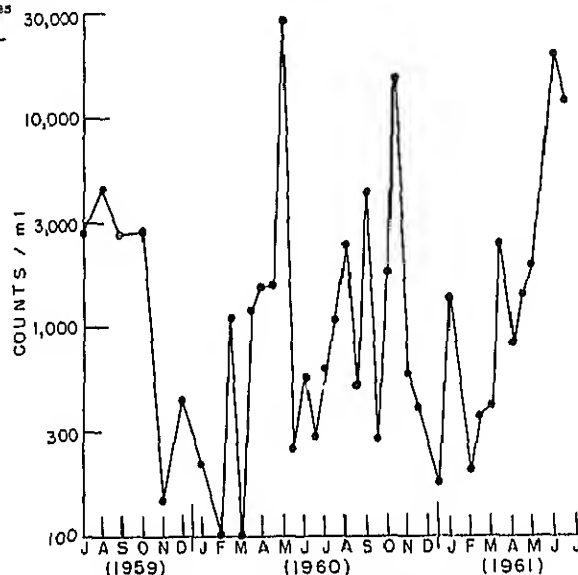
Green algae	
Actinastrum	3
Ankistrodesmus	0
Chlorella-type	6
Closterium	3
Coccolithus	3
Crucigenia	3
Dictyosphaerium	3
Oocystis	6
Pediastrum	0
Scenedesmus	28
Staurastrum	3

Green flagellates	
Chlamydomonas	11

Other pigmented flatellates	
Chromulina	0

Diatoms	
Centric	
Cyclotella	28
Melosira	6
Stephanodiscus	28

Pennate	
Cymbella	3
Diatoma	6
Gomphonema	3
Navicula	17
Nitzschia	11
Surirella	3
Synedra	31

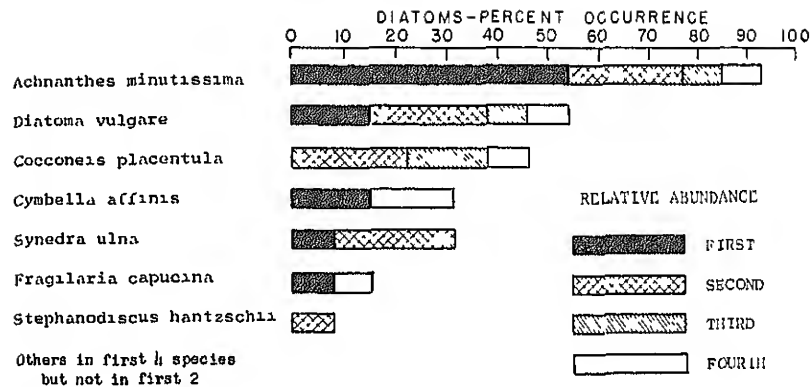


TOTAL LIVE PHYTOPLANKTON COUNTS

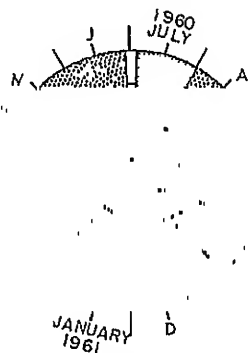
Months
June-Sept, 2,612

POTOMAC RIVER WILLIAMSPORT, MD.

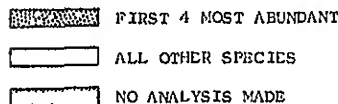
Limnology samples
from July 1960 to July 1961



Cymbella ventricosa
Gomphonema parvulum
Navicula cryptocephala
Navicula hungarica
Navicula sp.
Nitzschia palea type
Synedra vaucheriae



DIATOMS - SPECIES DIVERSITY



ZOOPLANKTON

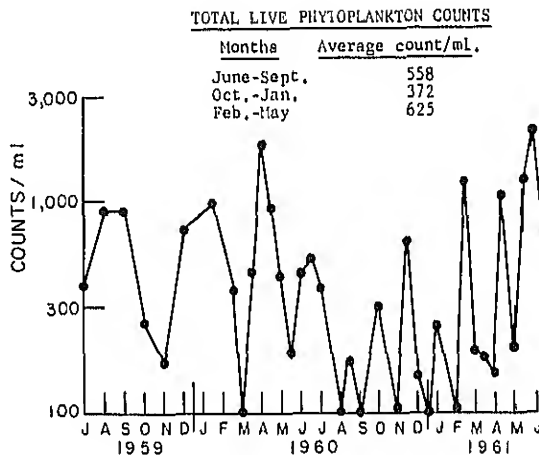
Samples analyzed 20
July 1960 to July 1961

Samples with Animals	Average count per liter per sample
Rotifers	1.4
Keratella	0
Polyarthra	0
Brachionus	0
Synchaeta	0
Other genera	1.1
Crustaceans nauplii	0.1
copepods	0
cladocerans	0.1
Nematodes	0
Other invertebrate metazoans	0

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

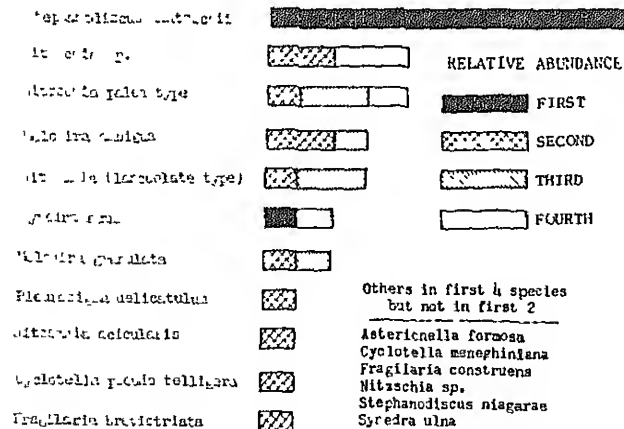
Blue-green algae	
Anacystis	3
Green flagellates	
Chlamydomonas	6
Diatoms	
Centric	
Cyclotella	11
Stephanodiscus	6
Pennate	
Achnanthes	3
Cymbella	14
Navicula	9
Synedra	23



RED RIVER (NORTH) GRAND FORKS, NORTH DAKOTA

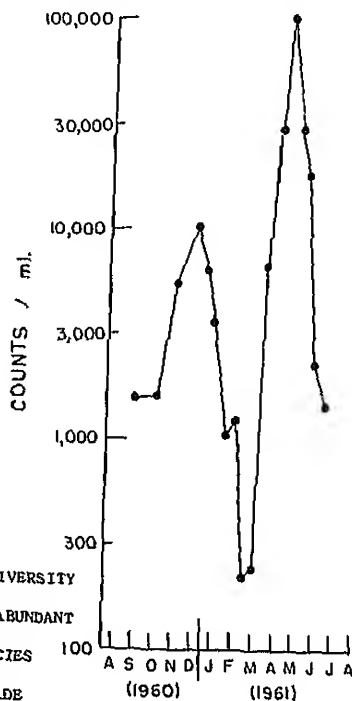
Seasonally Samples
from Sept. 1960 to July 1961

DIATOMS - PERCENT OCCURRENCE

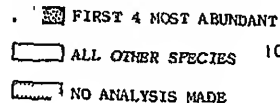


TOTAL LIVE PHYTOPLANKTON COUNTS

Months	Average count/ml.
June-Sept.	1,798
Oct.-Jan.	13,221
Feb.-May	24,015



DIATOMS - SPECIES DIVERSITY



ZOOPLANKTON

Samples analyzed 18
Nov. 1960 to Aug. 1961

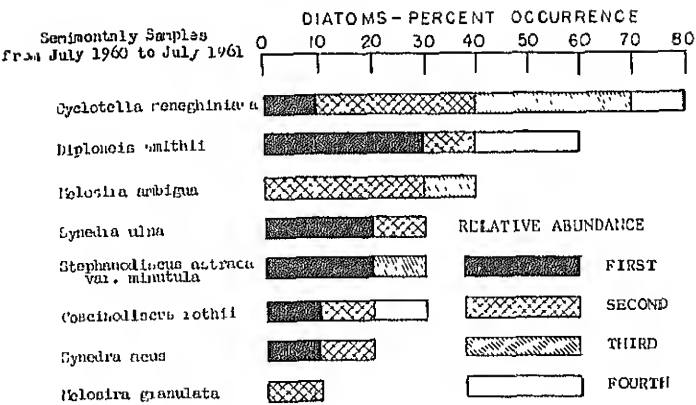
Samples with Animals	Average count per liter per sample
Rotifers.	13
Keratella	9
Polyarthra	8
Brachionus	5
Synchaeta	9
Other genera	9
Crustaceans.	6
nauplii	5
copepods	2
cladocerans	0
Nematodes	2
Other invertebrate metazoans	0

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From Sept. 1960 to July 1961

Blue-green algae	
Oscillatoria	5
Raphidiopsis	5
Green algae	
Ankistrodesmus	11
Dictyosphaerium	5
Scenedesmus	29
Green flagellates	
Chlamydomonas	31
Phacotus	4
Trachelomonas	28
Other pigmented flagellates	
Chromulina	6
Peridinium	4
Diatoms	
Centric	
Cyclotella	11
Melosira	17
Stephanodiscus	94
Pennate	
Asterionella	5
Cymatopleura	5
Cymbella	7
Gomphonema	6
Nitzschia	17
Pleurosigma	5
Synedra	36

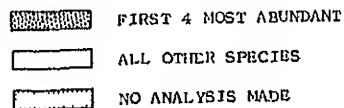
RED RIVER (SOUTH) ALEXANDRIA, LOUISIANA



Others in first 4 species
but not in first 2

Amphipora sp.
Eunotia sp.
Nitzschia acicularis
Opophora sp.
Stephanodiscus hantzschii
Stephanodiscus

DIATOMS - SPECIES DIVERSITY



ZOOPLANKTON

Samples analyzed 17
July 1960 to July 1961

Samples with Animals	Average count per liter per sample
Rotifers: 13	48.8
Keratella 3	43.0
Polyarthra 3	1.5
Brachionus 1	0
Synchaeta 0	0
Others 9	6.3
Crustacea: Nauplii 0	0
Copepods 1	0
Cladocera 0	0
Nematodes	1
Other invertebrate metazoans	0

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Blue-green algae

Agratellum	16
Anabaena	13
Anacystis	19
Arthrospira	3
Oscillatoria	13
Phormidium	6
Spirulina	3

Green algae

Ankistrodesmus	16
Chlorella	3
Crucigenia	3
Oocystis	19
Scenedesmus	10
Staurastrum	3
Tetradonema	3

Green flagellates

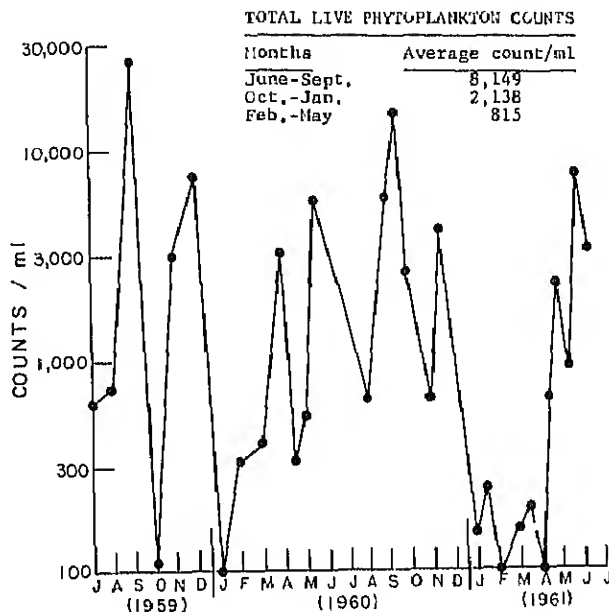
Chlamydomonas	13
Trachelomonas	3

Diatoms

Cyclotella	3
Coscinodiscus	35
Cyclotella	13
Helosira	16
Stephanodiscus	16

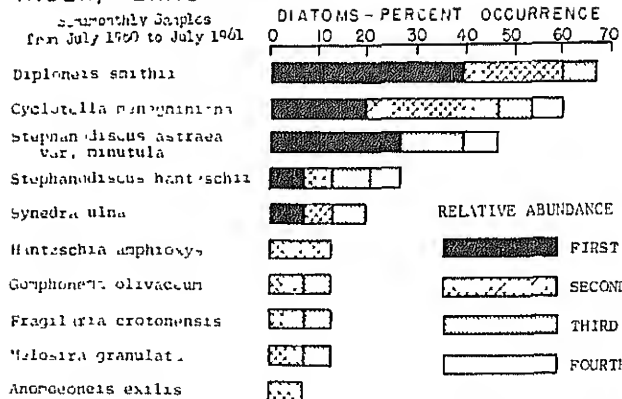
Femate

Cocconeis	6
Diploneis	16
Mastocella	6
Nitzschia	16
Synedra	29



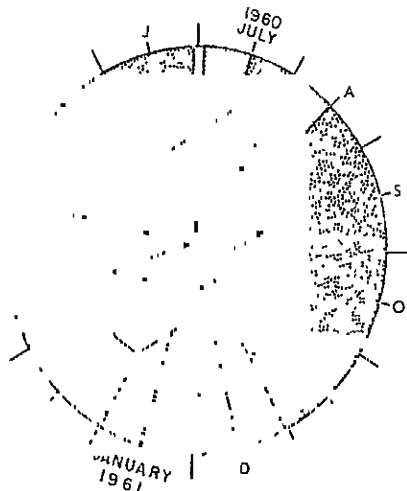
RED RIVER(SOUTH) INDEX, TEXAS

Seasonally Samples
from July 1960 to July 1961



Others in first 4 species
but not in first 2

Biddulphia laevis
Cyclotella sp.
Melosira ambigua
Navicula sp.
Nitzschia acicularis
Nitzschia dissipata
Stephanodiscus sp.
Surirella anustata



DIATOMS - SPECIES DIVERSITY

FIRST 4 MOST ABUNDANT
ALL OTHER SPECIES
NO ANALYSIS MADE

ZOOPLANKTON

Samples analyzed 23
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers	11	8.0
Keratella	8	3.5
Polyarthra	5	0
Brachionus	6	1.7
Synchaeta	4	1.6
Other genera	6	1.2
Crustaceans		
nauplii	0	0
copepods	1	0
cladocerans	0	0
Nematodes	3	
Other invertebrate metazoan	0	

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
170 per ml. or more
from Sept. 1959 to May 1961

Blue-green algae

Agranellum	70
Anabaena	5
Anacyclops	70
Aphanizomenon	2
Gomphonema	2
Ocellularia	2
Naphidolepis	2

Green algae

Actinotrium	5
Ankistrodesmus	11
Chlorococcum	5
Chlosterium	2
Coelastrum	8
Cruetella	11
Dictyosphaerium	2
Lagorhemia	7
Coenococcus	45
Coenodermis	37
Tetradium	8
Tetradium	2

Green flagellates

Chlamydomonas	31
Euglena	5
Tracholomonas	11

Other pigmented flagellates

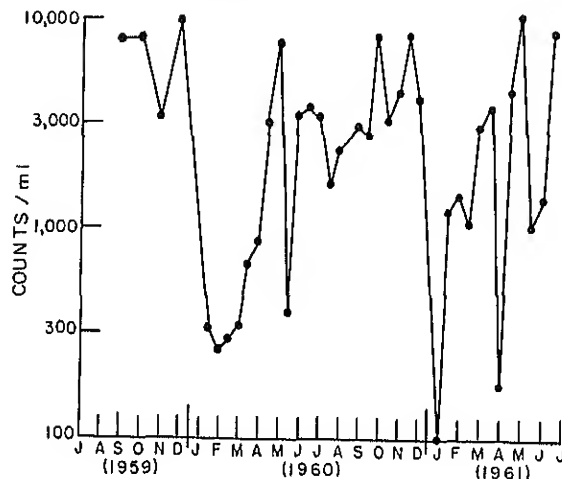
Chromulina	5
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Diatoms

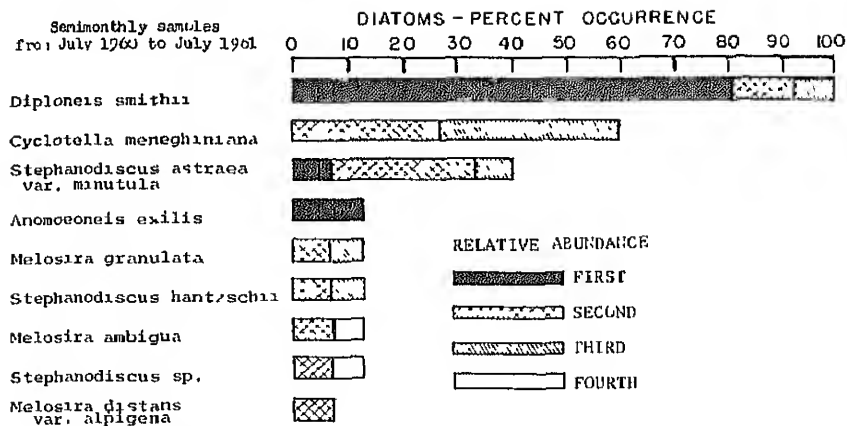
Cyclotella	34
Melosira	5
Rhizosolenia	2
Stephanodiscus	70

TOTAL LIVE PHYTOPLANKTON COUNTS

Months	Average count/ml.
June-Sept.	3,635
Oct.-Jan.	4,395
Feb.-May	2,034

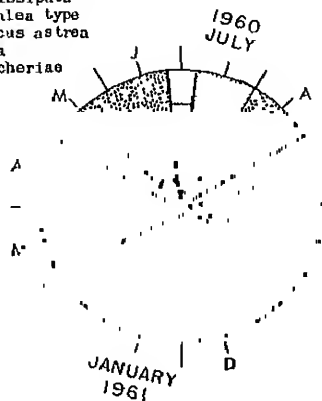


RED RIVER (SOUTH) DENISON, TEXAS

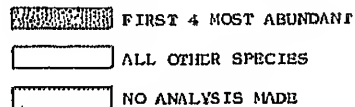


Others in first 4 species
but not in first 2

Chaetoceros sp.
Coscinodiscus rothii
Nitzschia dissipata
Nitzschia palea type
Stephanodiscus astraea
Synedra ulna
Synedra vaucleriae



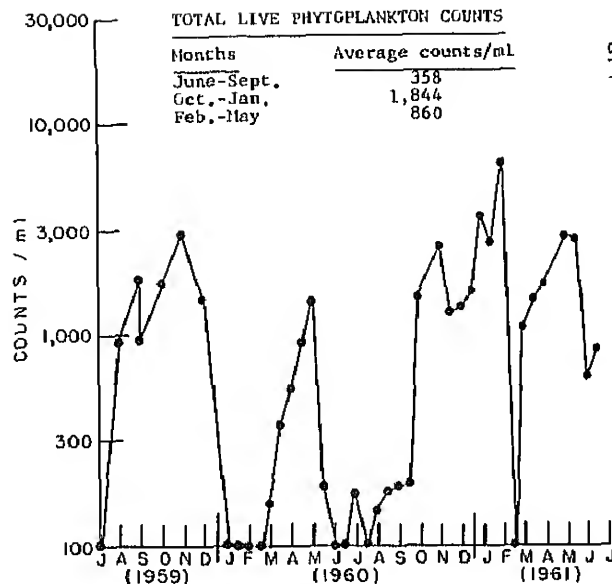
DIATOMS - SPECIES DIVERSITY



ZOOPLANKTON

Samples analyzed 22
July 1960 to July 1961

Samples with Animals	Average count per liter per sample
Rotifers	12
Keratella	8
Polyarthra	1
Brachionus	3
Synchaeta	3
Others	7
Crustacea	
Nauplii	9
Copepods	8
Cladocera	11
Other invertebrate metazoans	0



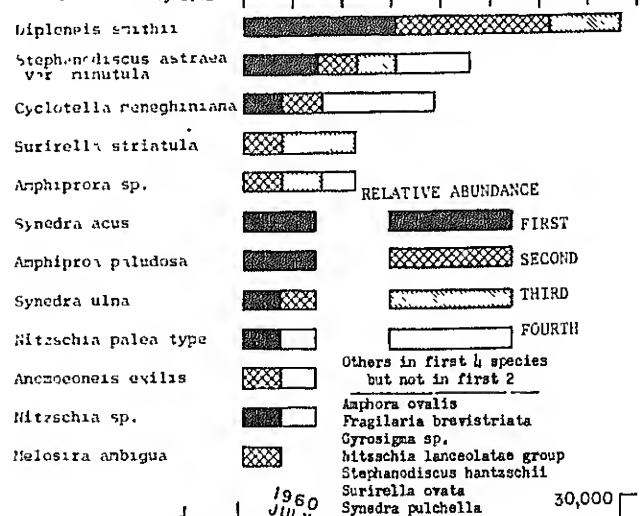
MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1957 to May 1961

Blue-green algae	
Anabaena	3
Anacystis	8
Oscillatoria	3
Green algae	
Crucigenia	11
Oocystis	37
Tetrastrum	3
Green flagellates	
Chlamydomonas	18
Phacotus	3
Trachelomonas	3
Diatoms	
Centric	
Coscinodiscus	3
Cyclotella	16
Melosira	3
Stephanodiscus	5
Pennate	
Cocconeis	5
Diploneis	29
Synedra	5

RIO GRANDE BROWNSVILLE, TEXAS

Horizontally, samples
from Jul. 1960 to July, 1961



ZOOPLANKTON

Samples analyzed 18
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers	11	137.2
Keratella	7	4.5
Polyarthra	5	0.9
Brachionus	3	1.3
Synchaeta	5	11.1
Other genera	7	119.4
Crustaceans:		
nauplii	2	0.3
copepods	5	0.4
cladocerans	0	0
Nematodes		1
Other invertebrate metazoans		0

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From Sept. 1959 to May 1961

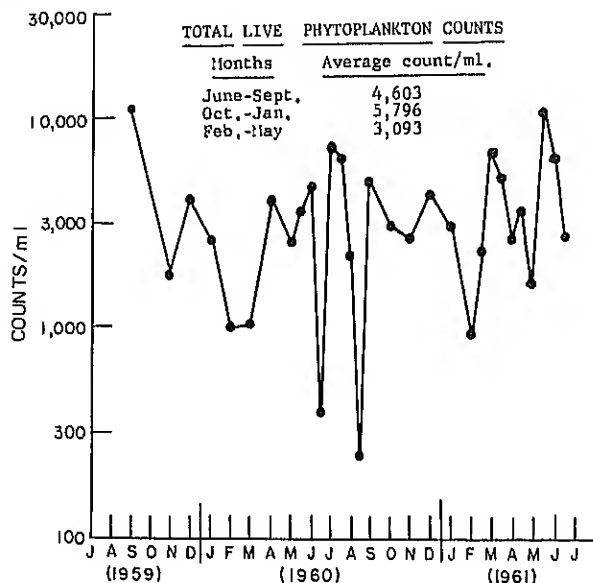
Blue-green algae	
Agmenellum	28
Anacystis	21
Green algae	
Ankistrodesmus	32
Chlorococcum	4
Cosmarium	4
Crucigenia	4
Nannochloris	4
Oocystis	20
Scenedesmus	52
Sphaerocystis	4
Teiradesmus	8
Green flagellates	
Chlamydomonas	12
Trachelomonas	8

Diatoms

Centric	
Cyclotella	28
Stephanodiscus	20

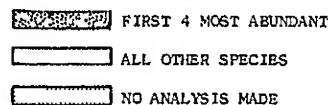
Pennate

Amphipleura	4
Amphiproxa	10
Amphora	4
Anomoeoneis	4
Cocconeis	12
Diploneis	32
Fragilaria	12
Navicula	36
Nitzschia	44
Pleurosigma	4
Surirella	12
Synedra	68



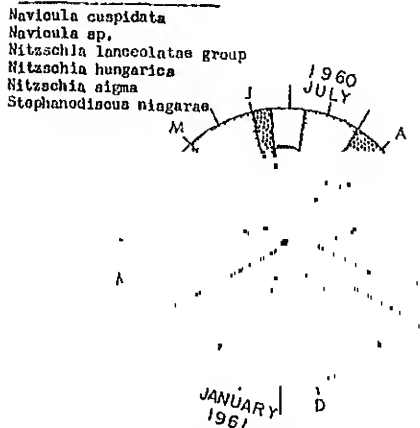
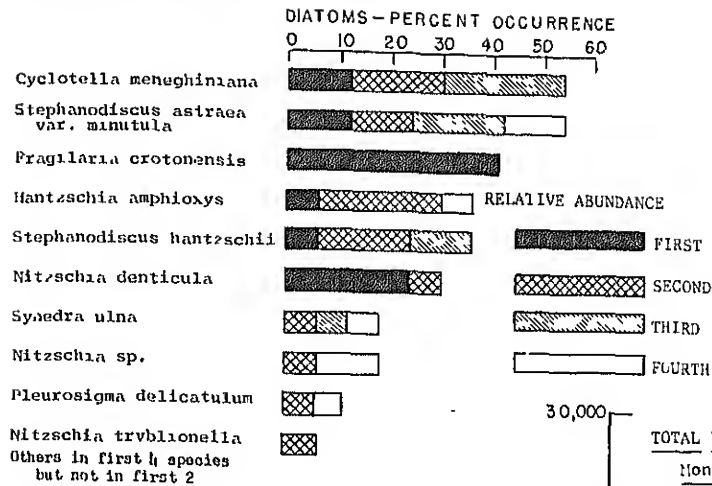
JANUARY 1961

DIATOMS - SPECIES DIVERSITY

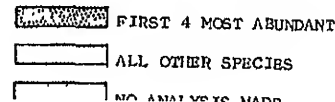


RIO GRANDE, LAREDO, TEXAS

Sedimental Samples
from July 1960 to July 1961



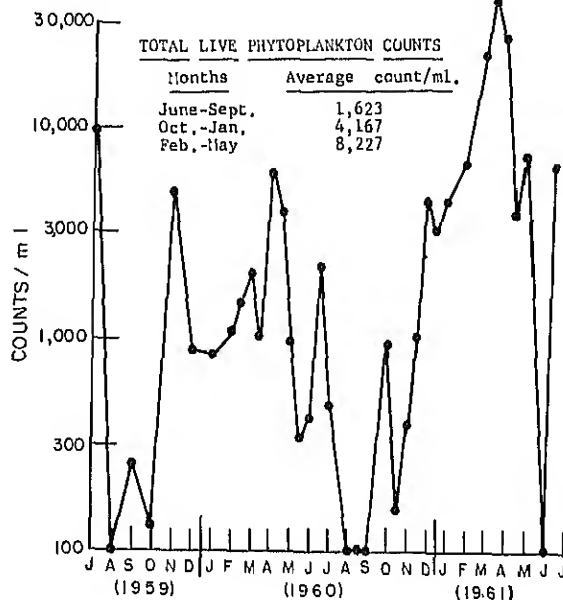
DIATOMS - SPECIES DIVERSITY



ZOOPLANKTON

Samples analyzed 18
July 1960 to July 1961

Samples with Animals	Average count per liter per sample
Rotifers:	1
Keratella	1
Polyarthra	0
Brachionus	0
Synchaeta	0
Other genera	0
Crustaceans:	
nauplii	0
copepods	0
cladocerans	0
Nematodes	5
Other invertebrate metazoans	0



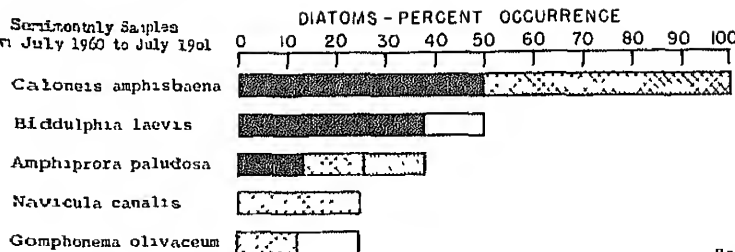
MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Blue-green algae	
Agmenellum	3
Anacystis	3
Oscillatoria	3
Green algae	
Ankistrodesmus	11
Chlorella-type	3
Closterium	6
Dictyosphaerium	3
Gloeocystis	3
Oocystis	3
Scenedesmus	17
Green flagellates	
Chlamydomonas	6
Other pigmented flagellates	
Dinobryon	3
Diatoms	
Centric	
Cyclotella	36
Stephanodiscus	33
Pennate	
Cocconeis	6
Cymbella	3
Fragilaria	17
Navicula	22
Nitzschia	22
Pleurosigma	3
Synedra	39

RIO GRANDE EL PASO, TEXAS

Surinontly Samples
from July 1960 to July 1961



Others in first 4 species
but not in first 2

RELATIVE ABUNDANCE

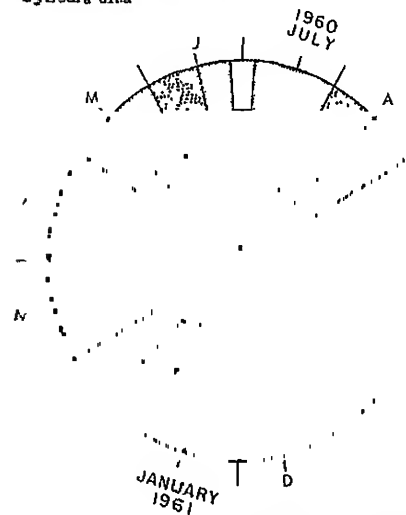
FIRST

SECOND

THIRD

FOURTH

Amphiprora alata
Diatoma vulgare
Navicula hungarica
Navicula sp.
Nitzschia lanceolatae group
Nitzschia sigma
Nitzschia sp.
Stephanodiscus hantzschii
Synedra ulna



DIATOMS - SPECIES DIVERSITY

FIRST 4 MOST ABUNDANT

ALL OTHER SPECIES

NO ANALYSIS MADE

ZOOPLANKTON

Samples analyzed 10
July 1960 to July 1961

Samples with Animals	Average count per liter per sample
Rotifers:	2.1
Keratella	0.7
Polyarthra	0
Brachionus	0
Synchaeta	0
Other genera	1.4
Crustaceans:	
nauplii	0
copepods	0.2
cladocerans	0.2
Nematodes	2.0
Other invertebrate metazoans	0

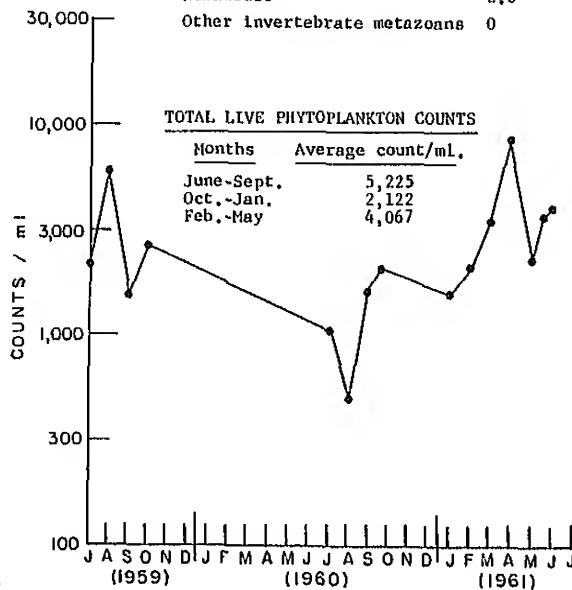
MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

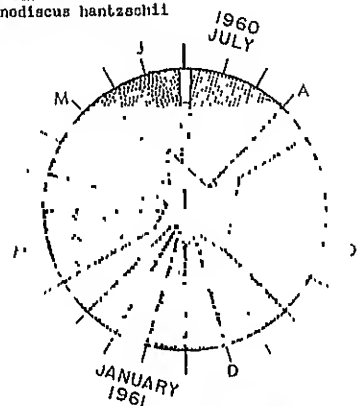
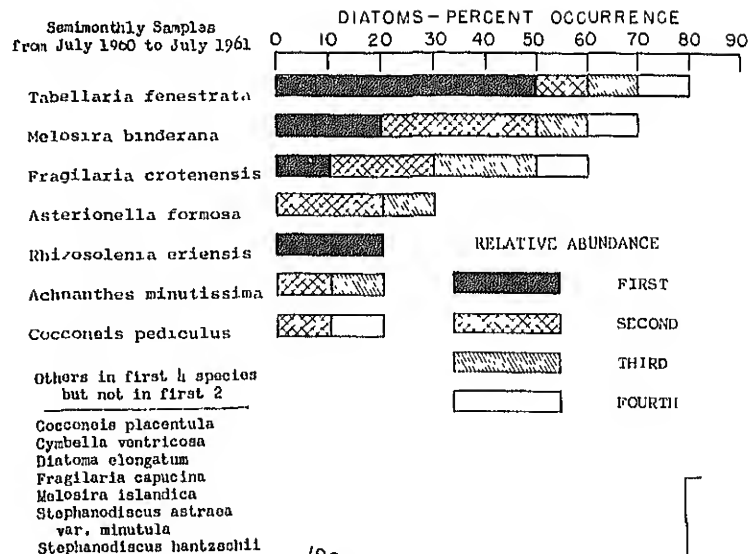
Blue-green algae	
Anacystis	13
Green algae	
chlorella-type	7
Chlorococcum	7
Lagerheimia	7
Scenedesmus	13
Green flagellates	
Chlamydomonas	20
Euglena	26
Trachelomonas	7

Diatoms	
Centric	
Biddulphia	13
Cyclotella	66
Melosira	13
Stephanodiscus	33

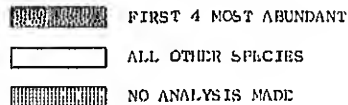
Pennate	
Amphiprora	26
Asterionella	7
Caloneis	33
Cocconeis	13
Gomphonema	7
Navicula	33
Nitzschia	47



ST LAWRENCE RIVER MASSENA, NEW YORK



DIATOMS - SPECIES DIVERSITY



ZOOPLANKTON

Samples analyzed 16
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers.	16	16.0
Keratella	15	7.3
Polyarthra	5	0.8
Brachionus	6	1.1
Synchaeta	6	0.6
Other genera	15	10.8
Crustaceans:		
nauplii	3	0.7
copepods	4	0.3
cladocerans	3	0.3
Nematodes		1.
Other invertebrate metazoans		0

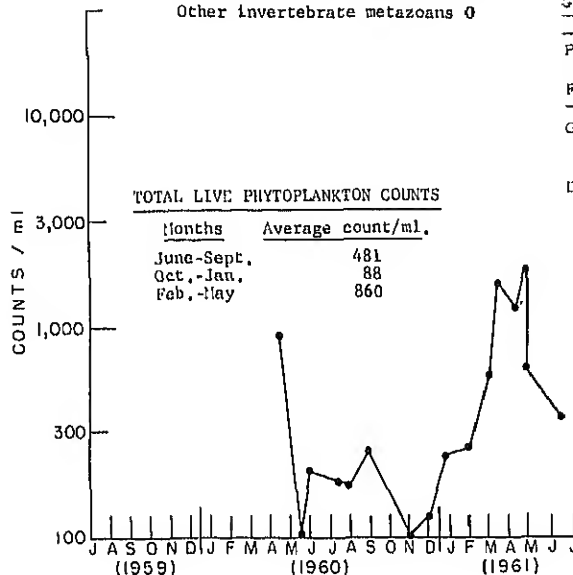
MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From April 1960 to August 1961

Green algae
Ankistrodesmus 10

Diatoms
Centric
Melosira 21
Stephanodiscus 31

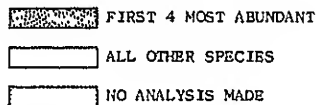
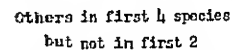
Pennate
Asterionella 10
Fragilaria 5
Tabellaria 15



DIATOMS-PERCENT OCCURRENCE

Semimonthly Samples from July 1960 to July 1961	0	10	20	30	40	50	60	70	80	90
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Melosira *distans*
var. *alpigena*



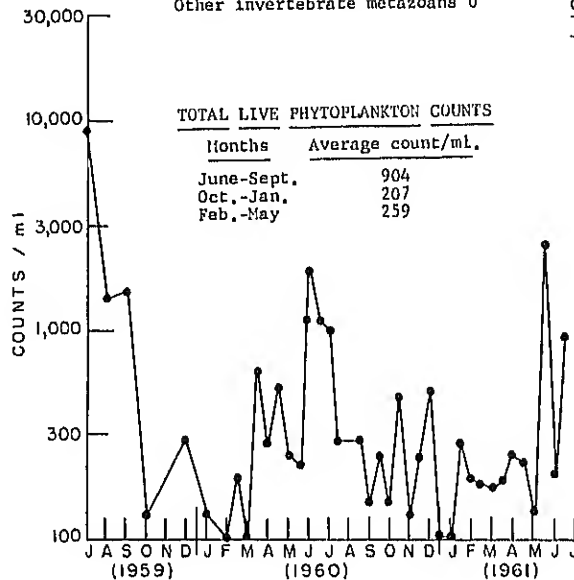
Samples analyzed 22
July 1960 to July 1961

M O S T A B U N D A N T
G E N E R A O F A L G A E

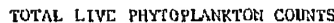
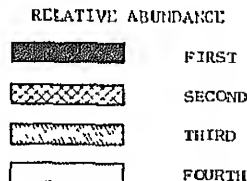
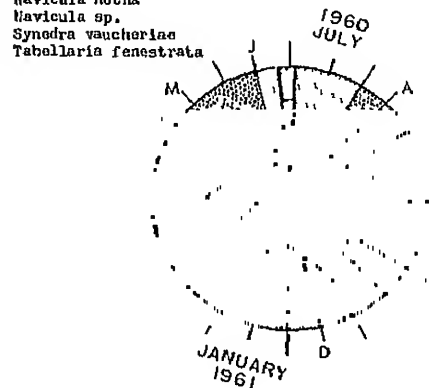
Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Blue-green algae	
Anacystis	2
Green algae	
Ankistrodesmus	2
Green flagellates	
Chlamydomonas	2
Diatoms	
Centric	
Cyclotella	7
Melosira	17
Stephanodiscus	2
Pennate	
Synedra	9

<u>Months</u>	<u>Average count/ml.</u>
June-Sept.	904
Oct.-Jan.	207
Feb.-May	259



Semimonthly Samples
from July 1963 to July 1964



<u>Months</u>	<u>Average count/ml.</u>
June-Sept.	422
Oct.-Jan.	186
Feb.-May	408

Samples analyzed 15
July 1960 to July 1961

M O S T A B U N D A N T
G E N E R A O F A L G A E

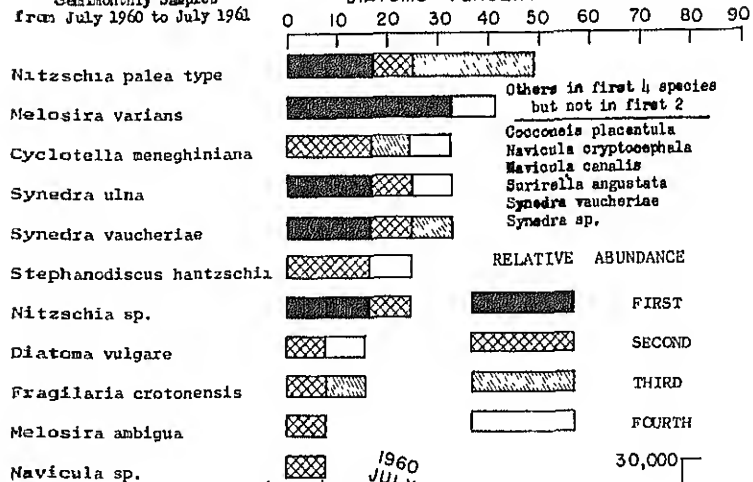
Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Blue-green algae	
Anacystis	4
Diatoms	
Centric	
Cyclotella	9
Pennate	
Synedra	9

SCHUYLKILL RIVER PHILADELPHIA, PENNSYLVANIA

Semi-monthly Samples
from July 1960 to July 1961

DIATOMS - PERCENT OCCURRENCE



DIATOMS - SPECIES DIVERSITY

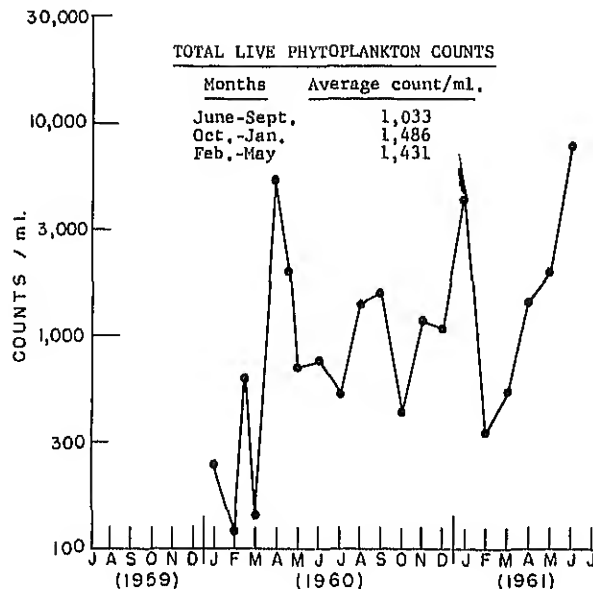
FIRST 4 MOST ABUNDANT

ALL OTHER SPECIES

ZOOPLANKTON

Samples analyzed 13
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers:	9	13.0
Keratella	2	0.5
Polyarthra	0	0
Brachionus	1	0.2
Synchaeta	1	0.1
Other genera	6	12.2
Crustaceans:		
nauplii	2	2.0
copepods	2	1.0
cladocerans	4	2.1
Nematodes		8.0
Other invertebrate metazoans		0



MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From January 1960 to May 1961

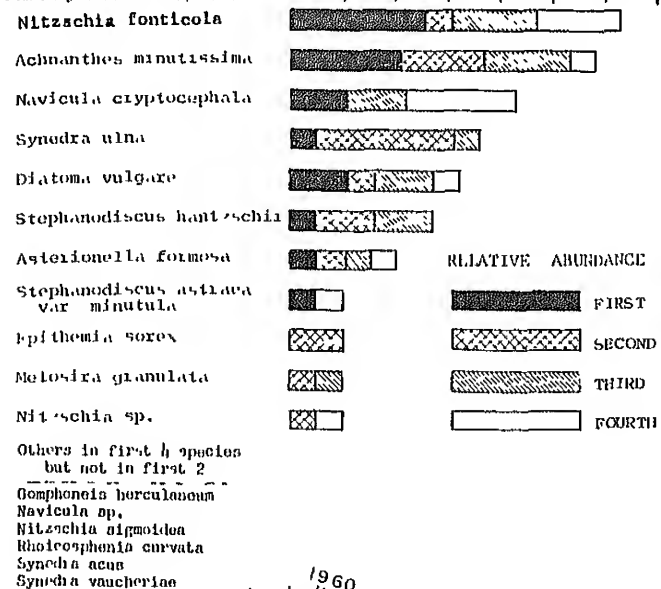
Green algae
Scenedesmus 11

Diatoms
Centric
Cyclotella 16
Melosira 5
Stephanodiscus 22

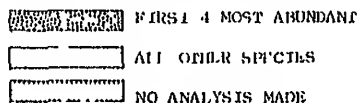
Pennate
Achnanthes 5
Diatoma 11
Gomphonema 5
Navicula 22
Nitzschia 33
Surirella 11
Synedra 33

Snake River Wawawai, Washington

Semimonthly Samples
from July 1960 to July 1961



DIATOMS - SPECIES DIVERSITY



ZOOPLANKTON

Samples analyzed 21
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rolfeia	14	4.7
Keratella	10	2.0
Polyarthra	2	0.5
Brachionus	4	0
Synchaeta	4	0
Other genera	7	2.2
Crustaceans:		
nauplii	1	0
copepods	0	0
cladocerans	0	0
Nematodes		1
Other invertebrate metazoans		0

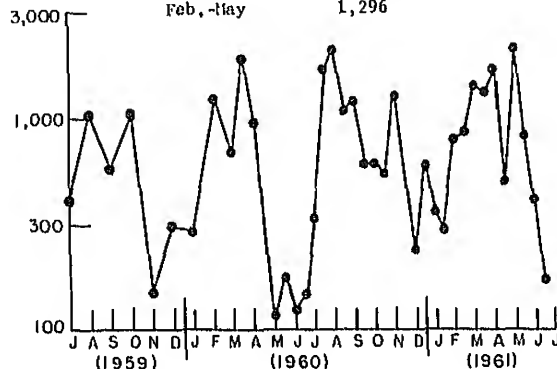
MOST ABUNDANT GENERA OF ALGAL

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

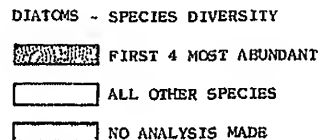
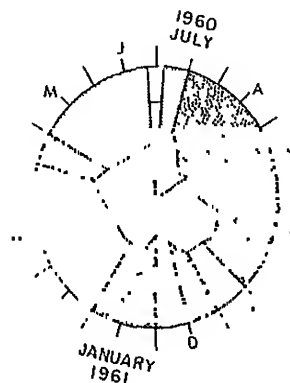
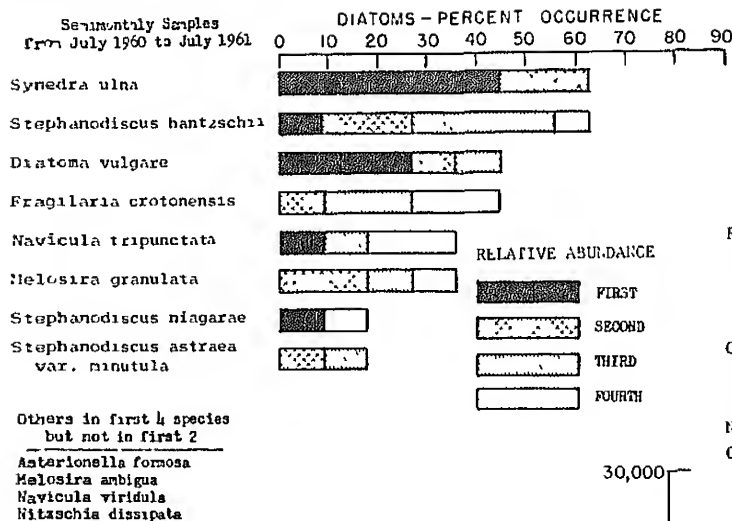
Green flagellates	
Chlamydomonas	3
Diatoms	
Centric	
Cyclotella	16
Melosira	8
Stephanodiscus	22
Pennate	
Achnanthes	11
Asterionella	8
Cymbella	1
Diatoma	8
Gomphonema	3
Navicula	24
Nitzschia	19
Synedra	30

TOTAL LIVE PHYTOPLANKTON COUNTS

Months	Average count/ml.
June-Sept.	1,067
Oct.-Jan.	536
Feb.-May	1,296



SNAKE RIVER WEISER, IDAHO



ZOOPLANKTON

Samples analyzed 13
 July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers.	12	18.8
Keratella	9	10.9
Polyarthra	5	1.8
Brachionus	8	1.0
Synchaeta	4	1.8
Other genera	10	16.6
Crustaceans nauplii	2	0.5
copepods	2	0
cladocerans	2	0
Nematodes		1
Other invertebrate metazoans		0

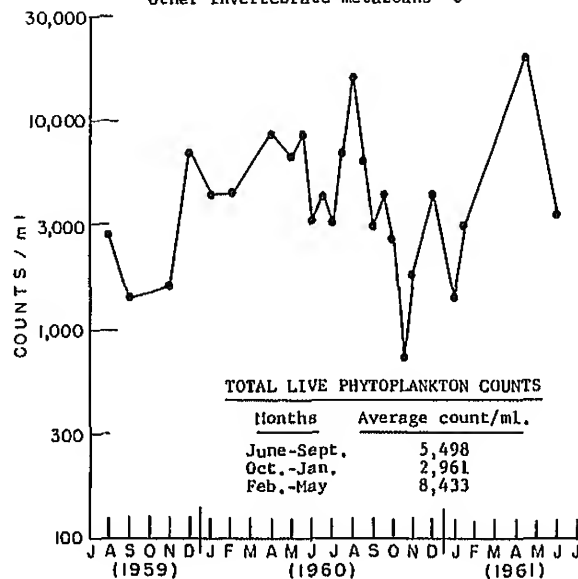
MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
 150 per ml or more
 From May 1959 to May 1961

Blue-green algae	
Anacystis	4
Oscillatoria	4
Green algae	
Micractinium	4
Scenedesmus	7
Green flagellates	
Chlamydomonas	22
Euglena	4
Other pigmented flagellates	
Chromulina	7

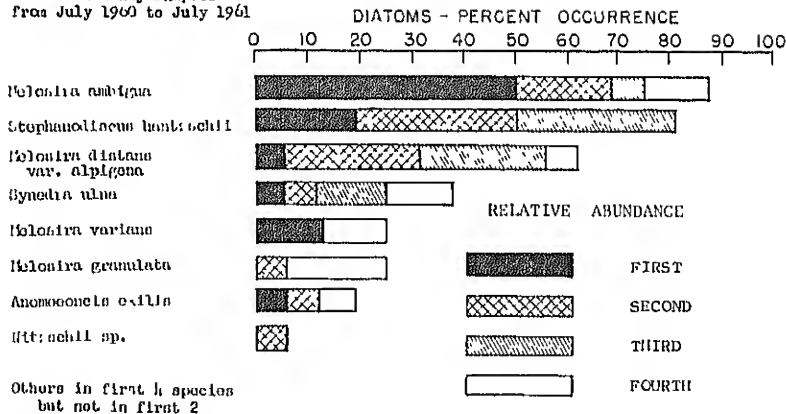
Diatoms	
Centric	
Biddulphia	4
Cyclotella	52
Melosira	30
Stephanodiscus	63

Pennate	
Achnanthes	11
Asterionella	7
Cocconeis	14
Cymatopleura	4
Cymbella	7
Diatoma	30
Fragilaria	37
Gomphonema	4
Navicula	63
Nitzschia	44
Synedra	85
Tabellaria	4

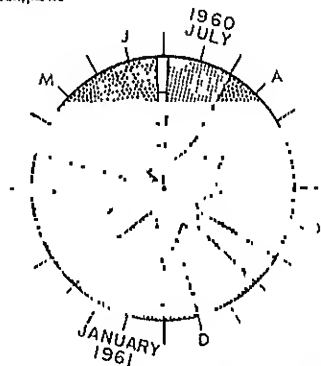


TENNESSEE RIVER CHATTANOOGA, TENNESSEE

Semimonthly Samples
from July 1960 to July 1961



Actinanthos minutissima
Anturionella formosa
Cocconeis placentula
Cyclotella pseudostelligera
Fragilaria crotonensis
Nitzschia holsatica
Stephanodiscus niagarae
Melosira sp.



DIATOMS - SPECIES DIVERSITY

FIRST 4 MOST ABUNDANT
ALL OTHER SPECIES
NO ANALYSIS MADE

ZOOPLANKTON

Samples analyzed 22
July 1960 to July 1961

	Samples with Animals	Average count per liter per sample
Rotifers.	18	22.5
Keratella	15	10.6
Polyarthra	9	5.0
Brachionus	4	0
Synchaeta	7	0.6
Other genera	11	3.0
Crustaceans, nauplii	3	0
copepods	2	0
cladocerans	2	0
Nematodes		2
Other invertebrate metazoans		0

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

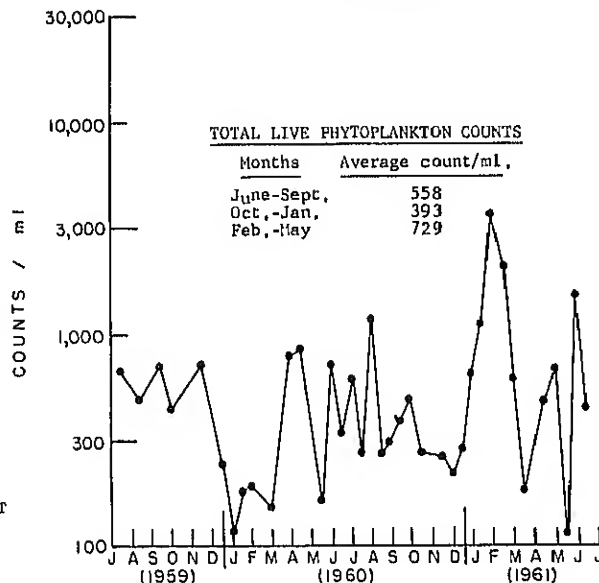
Green algae
Scenedesmus 2

Diatoms
Centric
Cyclotella 2
Melosira 25
Stephanodiscus 18

Pennate
Asterionella 2
Fragilaria 2
Synedra 7

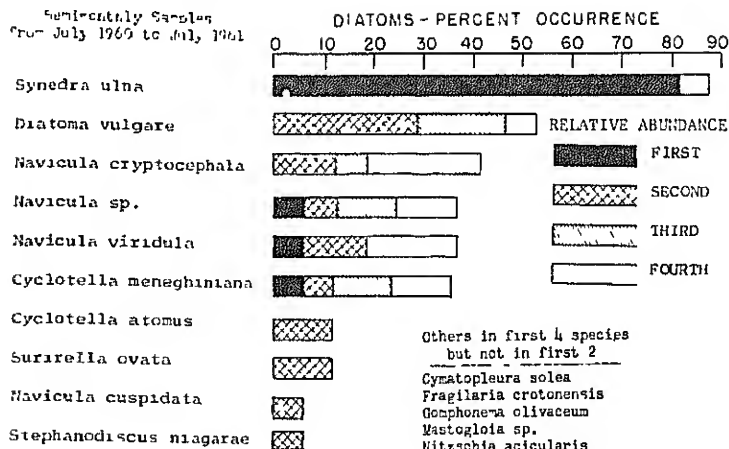
TOTAL LIVE PHYTOPLANKTON COUNTS

Months	Average count/ml.
June-Sept.	558
Oct.-Jan.	393
Feb.-May	729



YELLOWSTONE RIVER SIDNEY, MONTANA

Semi-regularly Sampling
from July 1960 to July 1961



ZOOPLANKTON

Samples analyzed 22
July 1960 to July 1961

Samples with Animals	Average count per liter per sample
Rotifers:	5
Keratella	2
Polyarthra	1
Brachionus	0
Synchaeta	1
Other genera	3
Crustaceans	
nauplii	2
copepods	0
cladocerans	0
Nematodes	2
Other invertebrate metazoans	0

MOST ABUNDANT GENERA OF ALGAE

Percent frequency of counts
150 per ml. or more
From May 1959 to May 1961

Blue-green algae
Anacystis 8
Gomphosphaeria 3

Green algae
Actinastrum 5
Ankistrodesmus 11
Gloeocystis 3
Oocystis 5
Scenedesmus 18
Tetradescmus 3

Green flagellates
Chlamydomonas 8
Trachelomonas 5

Diatoms
Centric
Cyclotella 26
Stephanodiscus 18

Pennate
Caloneis 3
Cocconeis 3
Cymbella 11
Diatoma 13
Epi themia 3
Fragilaria 16
Gomphonema 8
Navicula 53
Nitzschia 34
Surirella 11
Synedra 55

TOTAL LIVE PHYTOPLANKTON COUNTS

Months	Average count/ml.
June-Sept.	6,093
Oct.-Jan.	876
Feb.-May	2,797

